Institute of Environmental Sciences (CML)

2020-2025 and outlook

Universiteit Leiden

Colophon

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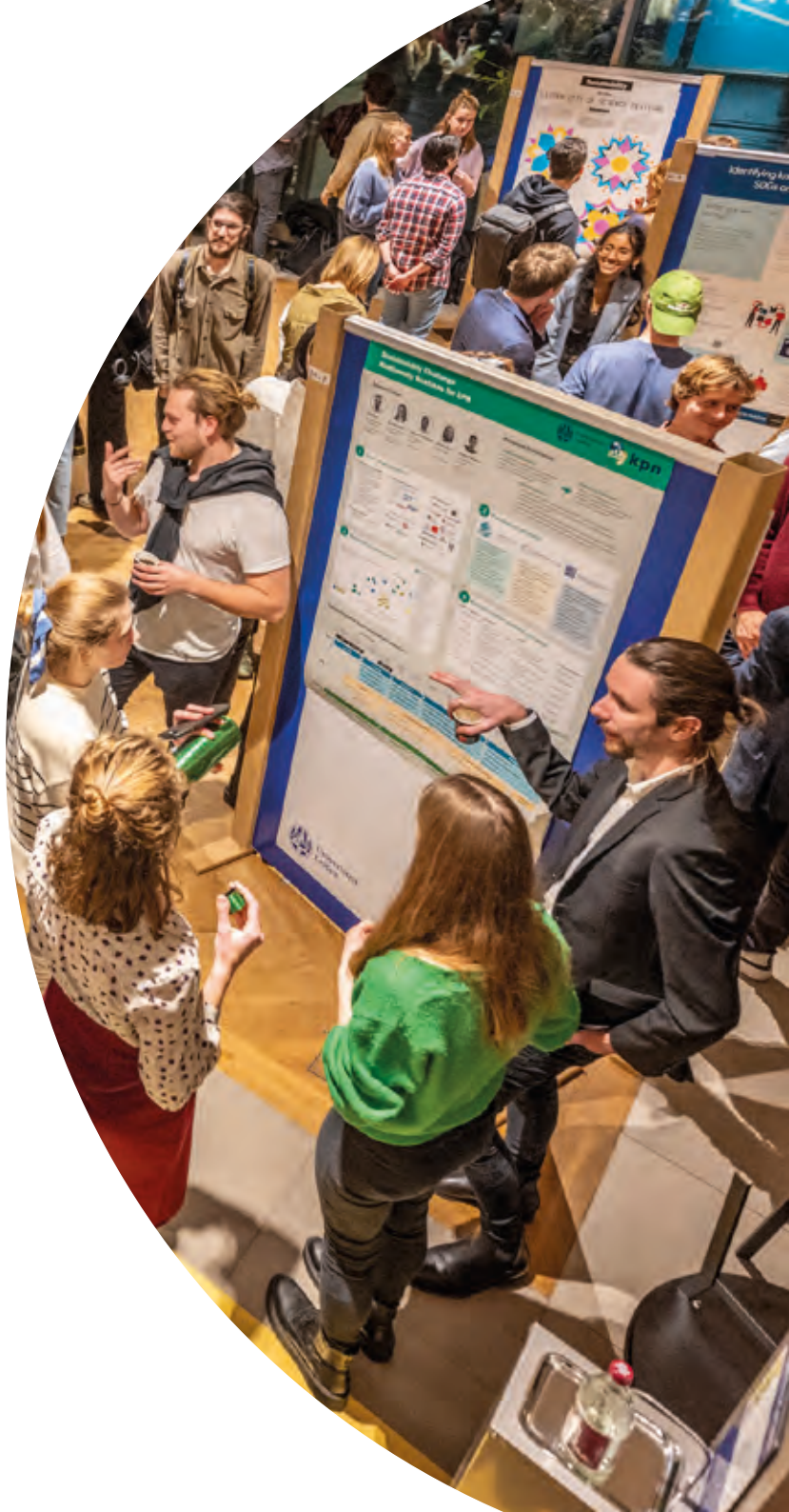


1 Introduction

1.1 CML self-evaluation report

Environmental research has never been more urgent, and over the past five years, CML has worked to address pressing sustainability challenges at both local and global scale. This report covers the period 2020–2025, during which the institute strengthened its scientific profile, expanded its educational portfolio, and further professionalised its organisation. Strategic investments, supported in part by the national *Sectorplan Bèta* en *Techniek* funding, enabled the consolidation of key research lines, the development of CML's own BSc programme and the growth of early-career researchers within a more stable and cohesive academic environment. Research support functions were expanded in parallel to match the institute's increasing scale. The COVID-19 pandemic had a significant impact on institute operations in 2020 and 2021: laboratory activities were disrupted, teaching formats required rapid adaptation, and everyday interaction within the institute changed for an extended period. Despite these constraints, core research and education activities continued, and several longer-term initiatives progressed largely as planned. CML hosted the International Society for Industrial Ecology (ISIE) conference and is currently organising a conference for the Society of Conservation Biology (ECCB 2026), reflecting the breadth and international standing of its research community.

This self-evaluation was developed through an inclusive, institute-wide process: three full staff meetings, two dedicated retreats, and two open rounds in which every principal investigator was invited to contribute directly. The process was designed not only to produce this report, but to foster shared ownership of CML's strategic direction across the whole community.

We are proud of the achievements of our staff and of the institutional developments of the past five years. The ways in which CML addressed and implemented the recommendations from the previous assessment period (2014–2019) are incorporated throughout the document and addressed point by point in Appendix G. The developments reflect an institute that has remained resilient, adaptive, and forward-looking, continuing to thrive while advancing its mission to contribute to sustainable societies through interdisciplinary environmental research and education.

1.2 Institutional mission and strategy

Founded in 1978, CML is one of the oldest Dutch environmental research institutes. CML's mission is to **contribute to sustainable societies by advancing scientific understanding and generating and analysing solutions for complex environmental challenges** that arise from the ways societies live, produce, and consume. Challenges such as pollution, resource depletion, climate change, urbanisation/industrialisation and biodiversity loss are deeply interconnected and require integrated, systems-based approaches.

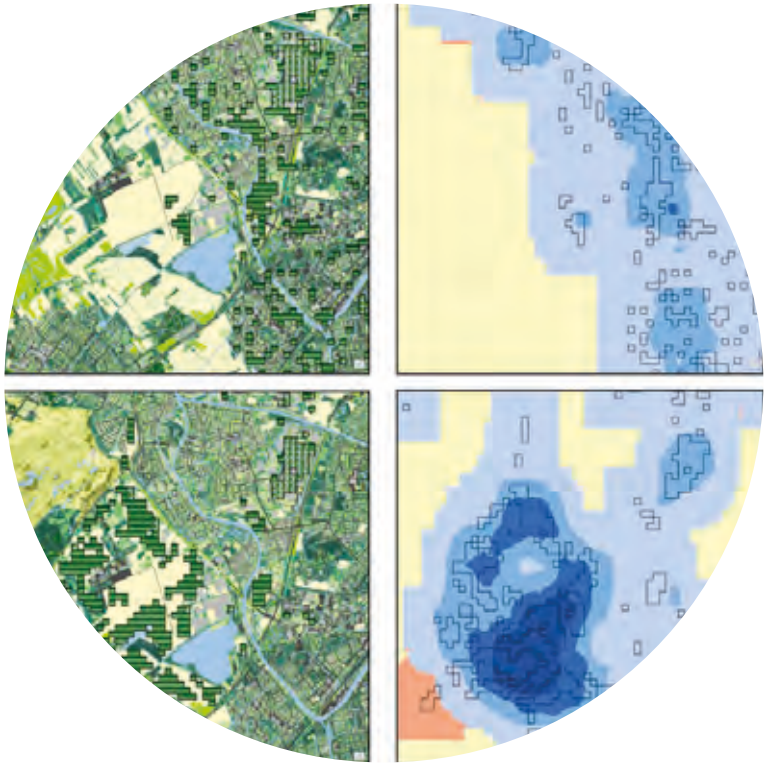
Two core values underpin CML's mission. The first, **exploratory curiosity**, drives the institute's research agenda. CML advances scientific understanding of how human activities affect biodiversity and ecosystem services, while also examining how societies' material foundations influence sustainability and human wellbeing. The second core value, **connection**, addresses environmental challenges by linking disciplines, scales, and forms of knowledge. Rather than limiting work to problem description, CML develops quantitative concepts, models, and analytical frameworks that support informed decision-making and help shape pathways towards a sustainable future from the local to the global scale.

To realize this mission, CML applies a coherent set of research strategies:

1. **Systems-based research.** CML research is grounded in systems thinking, viewing environmental challenges as interconnected systems. Rather than focusing on isolated components, our work analyses interactions, feedback, and trade-offs between ecological processes, resource use, and societal dynamics.
2. **Interdisciplinary integration.** Environmental challenges require the integration of insights from natural sciences, social sciences, and quantitative modelling. CML connects disciplinary perspectives to address environmental change in its ecological, economic, and societal dimensions.
3. **Development of quantitative tools.** A core strategic focus lies in the development and application of quantitative tools, particularly within the socio-ecological domain, complemented by analytical frameworks from governance and social sciences.
4. **Scaling.** CML bridges local, case-based knowledge all the way to global modelling approaches. Empirical insights from specific contexts inform broader assessments, while regional and global analyses are confronted with detailed, context-specific data.
5. **Connecting fundamental and applied research.** Fundamental research at CML underpins applied work addressing concrete societal challenges. Methodological innovation and real-world applications are developed in close interaction, ensuring that advances in environmental science translate into practical knowledge.
6. **Bridging science and policy.** CML engages with policymakers, public authorities, and societal stakeholders to ensure that scientific insights inform decision-making. Through advisory roles, policy engagement, and transdisciplinary initiatives such as living labs, research findings are connected to societal needs and policy development.

These research strategies position CML as a leading institute in the development of quantitative tools and conceptual innovations in environmental science, now explicitly addressing the earlier recommendation (period 2014-2019, see Appendix G) to identify and communicate its unique and world-leading strengths. Collaboration is essential to CML research. CML works closely with researchers across the Faculty of Science, within Leiden University, and with national and international partners.

CML's research and strategic choices underpin its organisational structure. The institute is organised into two complementary departments. The Environmental Biology department develops and applies methods to quantify ecological processes, environmental stressors, and biodiversity responses to human impacts. The Industrial Ecology department develops and applies methods to analyse material and energy use in society and their associated environmental impacts. The two departments form a strong synergy in addressing environmental challenges, sustainability questions and contribute to a common, systems-oriented research agenda. CML's staff examine the impacts of environmental stressors, including chemical pollution, climate change, and land-use change, across multiple biological and spatial scales, ranging from molecular and organism-level responses to ecosystem functioning, ecosystem services and global biodiversity patterns. Process-based insights are tested in field-representative settings to account for ecological dynamics and real-world complexity. To support this work, CML develops and applies monitoring approaches, satellite observations, modelling frameworks, and data pipelines that enable lab–field extrapolation and spatially explicit assessments. The institute research integrates concepts such as biodiversity impact assessments, environmental risk assessment, and ecosystem services, with methods that quantify resource use and environmental impacts, including life cycle assessment (LCA), material flow analysis (MFA), and environmentally extended input–output analysis (EIOA). CML also supports trade-offs management with Multiple Criteria Decision Analysis methods. In later sections of this report, we describe how these methods are applied in specific research domains, collaborations, and policy contexts.



2 Organisation

CML is embedded within the Faculty of Science at Leiden University and operates with a departmental structure complemented by cross-cutting research programmes. The departments are responsible for scientific development, staffing, and daily operations, while research programmes connect research activities to societal challenges. Beyond research, CML scientists are deeply committed to high-quality education (see Appendix E for the teaching programmes listed). CML is advised by councils, a committee and an Advisory Board.

2.1 Organisational structure

Responding to the growth, CML implemented a revised organisational structure from mid-2021 onwards. The institute is organised around the two departments mentioned earlier, Industrial Ecology and Environmental Biology (Figure 1). These departments form the core units of the institute. Within the departments, research concepts and methods are developed, and responsibilities for staffing, finances, and acquisition of external funding are organised under the leadership of two department heads.

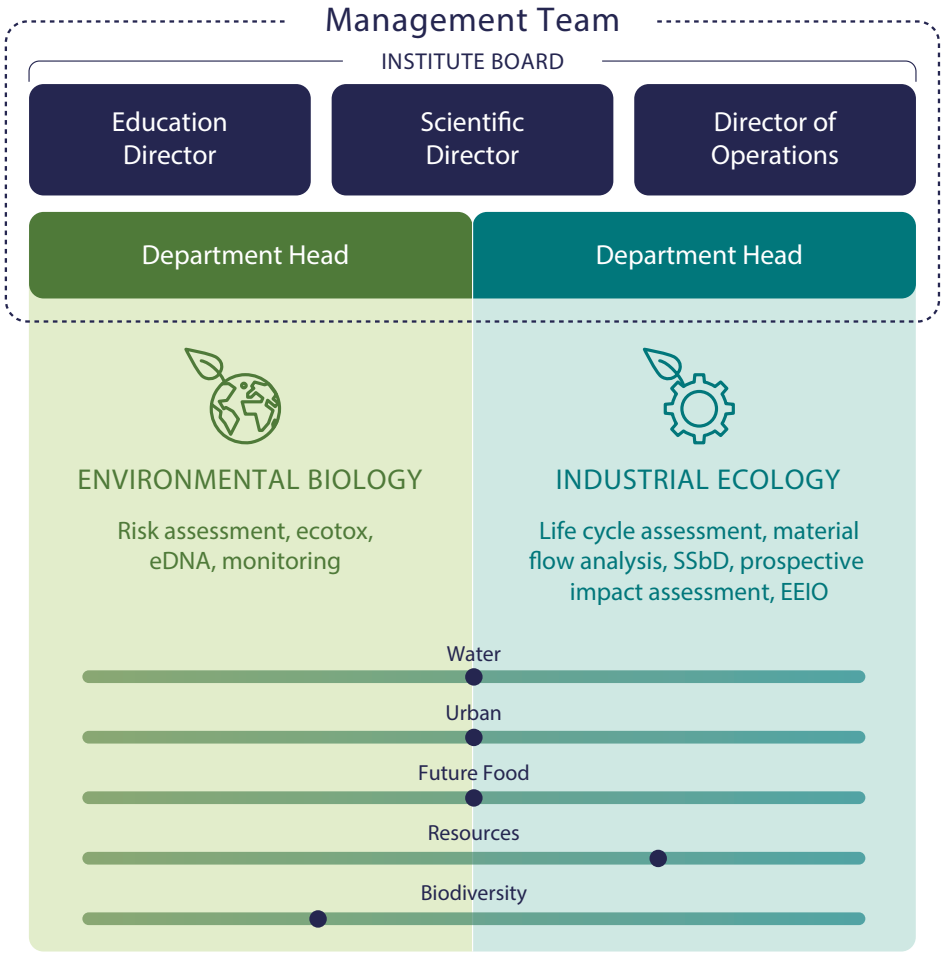


Figure 1: CML's organisational structure, including management, the Environmental Biology and Industrial Ecology departments, and cross-cutting research programmes. The bar shows the connection between the departments, and the bullet shows the ratio.

In addition to the departmental structure, CML established five cross-cutting research programmes (Figure 1). The introduction of these programmes followed recommendations from the previous SEP evaluation (2014–2019) and was intended to further development of CML's research agenda. The research programmes operate across departmental boundaries and provide a structured framework for collaboration and the integration of expertise across disciplines and scales. This combined departmental and programme-based model supports both vertical organisation within departments and horizontal connections across the institute. Our organisational model enhances coordination among researchers with complementary expertise and fosters collaborative research that extends beyond individual principal investigator–led projects. In addition, the programmes create leadership opportunities for assistant and associate professors and strengthen internal coordination and the visibility of CML's research activities.

In addition to its scientific staff, CML is supported by dedicated professional staff who facilitate research, education, and management. This includes a research support team, a technician team, office management, and a board secretary. CML also hosts the LDE Centre for Sustainability, including its knowledge brokerage team. Educational support is provided by a dedicated education team.

2.2 Management structure

CML has since the summer of 2024 operated under a collegial management model. This model is aligned with governance structures at the Faculty and University levels and is designed to support shared responsibility and collective decision-making. The Institute Board comprises the scientific director, the director of education and the director of operations, who are jointly responsible for the institute. The Management Team (MT) consists of the three directors and is further complemented by two department heads (Figure 1). The MT is supported by a board secretary. Each MT member has clearly defined responsibilities, while strategic decisions are discussed and agreed upon collectively within the team.

The MT is tasked with setting strategic priorities and maintaining the financial and organisational sustainability of the institute. This includes oversight of research and educational activities, staffing and resource allocation, and long-term planning. The collegial structure supports coordination across departments and programmes and provides a framework for balanced and transparent decision-making and management.

2.3 Committee, councils and advisory board

Institute's Council The CML Institute's Council consists of seven persons formally representing academic permanent staff, technicians, temporary staff like post docs and PhD candidates who are working in the institute. The Council advises the management team on a broad range of topics that concern all CML staff members. It convenes monthly and meets four times a year with the MT.

PhD Committee The PhD Committee organises social and academic events throughout the year. These include sports days, mental health workshops, academic writing weekends, career events and pub quizzes. The PhD Committee also represents and communicates on behalf of the PhD candidates with the MT and towards the Faculty Council of Science, the Faculty Council of the Graduate School of Science, other university councils, student associations (e.g., SHIFT, GOSSA, the LGBT+ Network of Leiden University). It meets monthly and four times a year with the MT.

Science Council The Science Council is an advisory council to the Board of the institute and consists of the institute's full professors. It meets four times a year and discusses the strategies at play at both the national and international level; they also serve as the institute's eyes and ears, helping to sense what drives research within the society.

Advisory Board The external Advisory Board advises the CML management team about general strategies, research and education activities and evaluation procedures. It meets twice a year.

Directors of the CML institute:
Prof.dr. Helias Udo de Haes (1978-2009)
Prof.dr. Geert de Snoo (2009-2012)
Prof.dr. Arnold Tukker (2013-2022)
Prof.dr. Martina Vijver (2022-now)
(*Photo: Barbra Verbij)*

CML Management team (2025-now):
René Kleijn, Jasper Williams, Krijn Trimbos, Martina Vijver, Stefano Cucurachi (*Photo: Barbra Verbij)*


Iron
Cobalt
Tc
Technetium
44 Ru
Ruthenium
45 Rh
Rhodium
Palladium
75 Re
76 Os
Osmium
77 Ir
Iridium
Bh
108 Hs
109

3 Academic culture

3.1 Staff numbers and diversity

During the assessment period, CML experienced a sustained growth in permanent staff. The permanent staff increased from 19 FTE in 2020 to 64.8 FTE in 2025. This reflects a deliberate expansion of research capacity and educational responsibilities. The details over the years are presented in Table E2 in Appendix A.

The current composition, gender* and age categories of CML staff (reference date December 2025) is given in Table 1. The recent growth was gradual and aligned with available funding, supervisory capacity, and organisational development. Next to employed FTEs, CML also has guest researchers of which four professors, and several researchers with a doctorate and many guests who are working on their PhD research (self-funded and scholarship PhD candidates).

31-12-2025	Total (FTE)	Male (FTE)	Female (FTE)	Age (<30)	Age (30-40)	Age (40-55)	Age (>55)
Professor[1]	5.8	4.8	1.0			2.0	3.8
Associate professor[2]	9.8	5.8	4.0		1.0	8.8	
Assistant professor	22.9	16.3	6.6		13.2	9.7	
Teacher	5.6	1.6	4.0	3.0	1.8	0.6	0.2
Support staff	16.5	3.8	12.7	5.0	5.6	5.9	
Support staff R&E	16.9	8.0	9.0	7.2	6.9	1.8	1.0
Researcher post doc	17.6	10.8	6.9	3.0	12.8	1.2	0.6
PhD candidate (employed)	67.7	35.9	31.7	44.5	23.2		
Student assistant	1.0	0.2	0.8	1.0			
Grand Total	**163.9**	**87.2**	**76.7**	**63.7**	**64.6**	**30.0**	**5.6**

Table 1: the current composition, gender* and age categories across the different function categories, based on **employed** FTEs (reference date 31/12/2025). R&E = Research & Education.

* *CML recognises that the male-female binary does not correspond to the full spectrum of genders existing in society. However, in order to give an impression of CML staff structure, this table presents an overview of sex as registered in the University's HR systems*

1 *At Leiden University, full and some associate professors have the 'ius promovendi', meaning that they can be appointed as formal promotors of PhD candidates according to the rules of the Graduate School. The total number of professors (employed or otherwise) with ius promovendi is 11.*

2 *There are in total 8 associate professors (employed or otherwise) with ius promovendi.*

The composition of the scientific staff is characterised by a relatively early career stage. More than three quarters of the researchers are under the age of 40, and staff represent a broad range of cultural and academic backgrounds. The average academic age (years since first publication) declined from 12 years in 2020 to 7 in 2025. This reflects the effectiveness of CML's hiring strategy and the successful integration of early-career researchers into the institute. CML deliberately invested in early- and mid-career appointments to build sustainable research lines, strengthen educational continuity, and create internal career pathways (also addressing the recommendation made in the period 2014-2019, see appendix G). This approach supports long-term viability by enabling progression into more senior roles from within the institute, rather than relying predominantly on external recruitment. Several early-career researchers progressed into permanent and more senior roles, including three postdoctoral researchers who advanced to assistant professor positions during the assessment period. Following recommendations from the previous assessment (2014–2019), CML also introduced a clearer postdoctoral career layer to support research continuity and talent development. Staff growth was accompanied by measures to support sustainable workloads (on average 35% teaching load across staff continuously monitored) and professional development. A structured staff review process was embedded, visibility of staff was enhanced through participation in strategic partnerships and large research consortia, and teaching loads for new staff were adjusted where financial conditions allowed.

CML has invested considerable effort in strengthening gender diversity, especially at the recruitment level (Figure 2). Looking ahead, within the next five years three male professors are expected to retire. This will further enhance the gender balance in the professorial pool. CML will actively stimulate internal career growth (see also Paragraph 3.3) and expects internal female talents to grow to the level of professor in the next 5-8 years. CML actively invests in the lifelong development of employees, both scientific and support staff (see Appendix F on Lifelong Learning support staff). Currently, 19 members of CML staff have the *ius promovendi*, meaning that they can be appointed as formal promotors of PhD candidates according to the rules of the Graduate School.

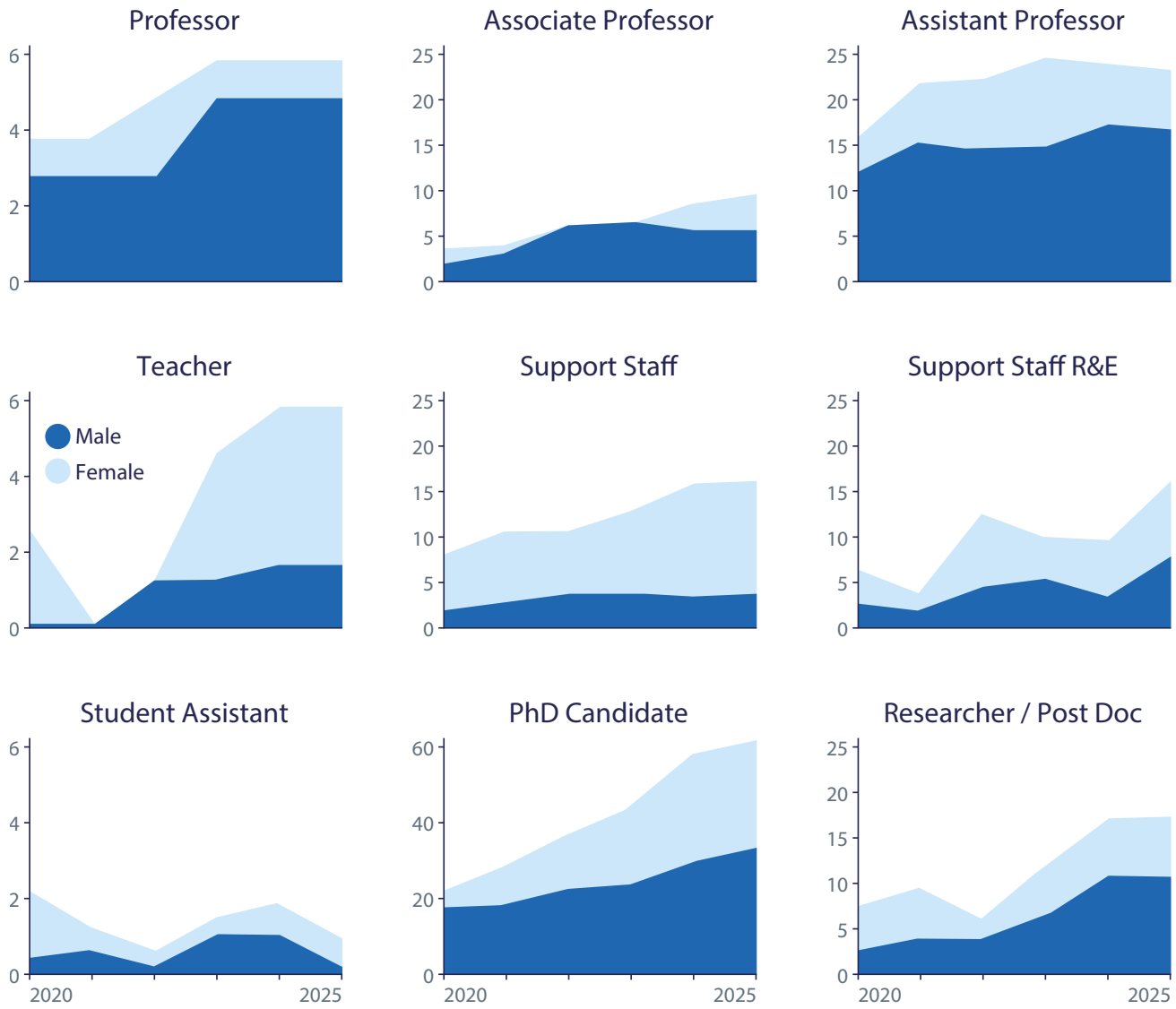


Figure 2: Staff composition at CML in FTE by position and gender (2020–2025). The figure shows the growth of the institute across academic, teaching, and support positions and the distribution of male and female staff across career stages. R&E = Research & Education. Please note that the y-axes do not all have the same scale.

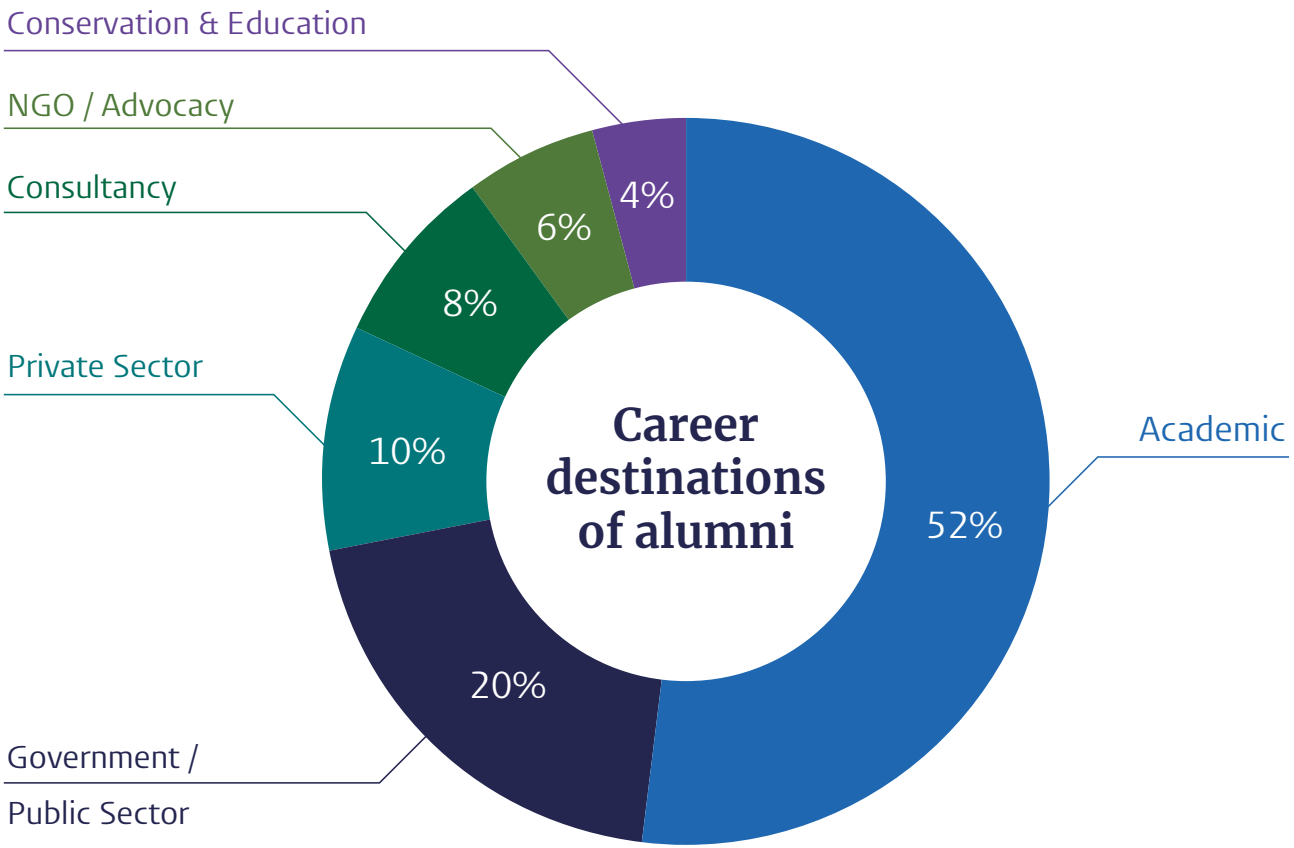
CML aims to foster a safe, healthy, and inclusive working environment in which diverse forms of talent and commitment are recognised, supported, and developed among both academic and support staff. Attention to social safety, integrity, and inclusion is embedded in institutional practices and daily operations. CML has a dedicated staff member as spokesperson for Diversity & Inclusion in the PhD community. CML has a Diversity & Inclusion (D&I) calendar, actively promotes equity and belonging through initiatives such as the CML Equity Day, which brings together staff and students to discuss and advance inclusive practices. CML is proud to have a colleague who is Board Member of the Queer Leiden University (QLU) student association, who also represents the QLU in the University's Diversity & Inclusion. CML's Operational Director is programme manager D&I at the Science Faculty. Scientific Director Martina Vijver co-founded Researchers in Science for Equality (RISE) in 2016 and was chair between 2016-2025. RISE is a platform for women in sciences at the Faculty of Science. As the first female Scientific Director in the Faculty of Science, Martina Vijver was awarded the NWO Athena Award in 2022, for being a role model.

CML highly values international and cultural diversity. Among staff in paid positions, 27 nationalities are represented, and 55% of all staff are Dutch. In addition, CML's guest PhD community, including external PhD candidates, comprises of 36 nationalities, with 45% of all candidates being Dutch. At CML, we are convinced that diverse teams contribute to our excellence in research and teaching and that such an inclusive environment creates a more stimulating and inspiring workplace.

Despite national and geopolitical developments that continue to affect the broader funding landscape, CML remains financially sound and resilient, with projected growth extending to 2030. In the coming years, the institute aims to further strengthen the balance between research (c. 45-55%), teaching (c. 35%), and academic service (c. 10-20%). Growth in staffing will therefore be **explicitly aligned with educational needs and with research themes** that fit the institute's mission. CML's funding portfolio is diverse and flexible. This allows the institute to adapt to changing conditions while sustaining research vitality. Simultaneously, CML recognises that continued growth introduces organisational and managerial demands. These are addressed proactively through departmental visions, cross-cutting research programmes, and internal coordination mechanisms that safeguard coherence and quality across the institute. The link between education and research remains strong and is consistent with Leiden University policy: all senior academic staff carry active teaching responsibilities, ensuring that students are closely connected to the institute's ongoing research and expertise.

3.2 PhD policy and training

Policy regarding supervision of PhD candidates has gradually been introduced during the evaluation period. PhD candidates are now supervised within a team of at least two supervisors. CML staff works according to the nine *Golden Rules* for PhD Supervision, as written in the PhD supervisor handbook developed by Leiden University. This provides a framework for clear expectations, regular feedback, and shared responsibility throughout the PhD process. All PhD candidates at CML are enrolled in the Graduate School of the Faculty of Science. Addressing the advice of the previous assessment period (see appendix G), each PhD candidate develops an Education and Supervision Plan with the supervisory team at the start of their appointment. This plan specifies research and education objectives, supervision arrangements, and training activities, and is reviewed and updated during their PhD trajectory. The PhD training programme consists of 140 hours of discipline-specific and academic skills training and 140 hours of transferable skills development. This training programme supports the PhDs in their conduct of research, academic writing, career orientation, and personal development.



At CML, we continue to serve as an **incubator for academic talent**. CML monitors the progression and outcomes of PhD trajectories as part of its broader quality assurance processes. Career tracking of PhD graduates provides insight into the range of career paths pursued within and beyond academia and informs ongoing reflection on the institute's research training environment (Figure 3).

Figure 3: Career destinations of CML alumni. Over half of alumni pursue academic careers, while others contribute to government and public agencies, the private sector, consultancy, NGOs and advocacy, and conservation and education, illustrating the broad societal relevance of CML doctoral training.

To ensure a consistent and supportive doctoral experience, CML has established a dedicated **PhD Support & Development Team**. This team, consisting of a professor and two PhD counsellors (function study advisors), is committed to helping candidates navigate their PhD journey successfully while ensuring compliance with the university-wide quality agreements. All PhD candidates meet with the team at the start of their appointment for an intake conversation and write their individual Education and Supervision plan mentioned earlier, within the first three months (also submitted to the Graduate School). Beyond these initial steps, candidates have an annual meeting with a team member to discuss well-being, progress, and any challenges they encounter. These sessions offer a confidential and supportive space, complementing the formal HR appraisal meetings (GROW). Through the Faculty of Science, CML PhD candidates have access to an independent, confidential advisor for consultations on integrity issues, addressing earlier recommendations. (see appendix G). Since its introduction in January 2024, the team has also developed a **PhD Handbook**, ensuring clear and transparent agreements across the institute and fostering a consistent, supportive environment where all PhD candidates can thrive both academically and personally.

With respect to outcomes, approximately one third of PhD candidates complete their defence within five years from the start date of their PhD trajectory (see mandatory Table E4 in

Appendix A). For most cohorts, completions are distributed primarily between five and seven years. After thesis submission, the time to defence is on average an additional three to five months. Approximately 8–10 PhD candidates hold hybrid appointments, combining their PhD with part-time external employment. This typically extends their trajectory to around six years. On average, two PhD candidates per cohort discontinue their PhD without defending their thesis. For those trajectories already starting at the signalling phase, HR guidance is given. The 2022 cohort showed a higher number of discontinuations (seven), attributable to a range of personal and contextual factors, including family circumstances, career reconsideration, and delays related to COVID-19 in the early phase of the project. With the implementation of the PhD support and development structure introduced in January 2024 and in interaction with the graduate school, CML staff aims to enhance the predictability and timely completion of PhD trajectories.

3.3 Human resources

Onboarding: CML explicitly addresses staff integration from the moment of appointment. New staff receive an onboarding magazine (Appendix H) containing practical information about the institute as well as guidance on living and working in Leiden and the surrounding region. New employees are welcomed through a structured "green carpet" introduction, including a mentor and buddy system, to support their integration into the institute. During onboarding, explicit attention is given to the Netherlands Code of Conduct for Research Integrity and to the individual responsibility of staff members to act in accordance with these principles.

Career planning: Policy regarding career planning has gradually been introduced during the evaluation period. When new staff members enter the institute, the department heads discuss expectations with them in bilateral meetings. Expectations are also on the agenda of GROW meetings. Across all career stages, CML places emphasis on good personal development, reflection on personal career and well-being, and effective functioning within the team. For those in formal leadership roles, expectations include accountability for team processes, guidance of colleagues, constructive decision-making, and fostering a collaborative working environment. The Faculty invests in leadership development through courses and a Faculty-wide learning pathway, with a focus on discovering one's own leadership style and strengthening leadership skills. To support consistency and transparency, Leiden University has formulated concrete competences that help map behaviour and expectations. These competences are not only a resource for GROW meetings, but can also be used for self-reflection, growth on a personal, professional and team level, and recruitment and selection. More information can be found here: *Develop your competences.*

In line with the institute's vision and strategy, the MT and the HR advisor jointly review the performance, potential, and development needs of all staff. This annual review, known as the **Vlootschouw**, takes place each August. Its purpose is to identify appropriate follow-up actions and to provide input for the GROW cycle. By doing so, the evaluation of staff is not dependent on a single management line, but benefits from a consistent approach and perspectives from different parts of the organisation. This also facilitates internal benchmarking. The direct line manager is responsible for collecting relevant information on each staff member, including research output, teaching activities, student supervision, contribution to organisational tasks, societal impact, and professional behaviour. Based on this, the MT develops a shared assessment of everyone's performance—drawing on GROW

criteria (results: what?; competences: how?)—and potential, using a three-level scale: potential reached, potential for further growth within the role, or promotable in time. Employability outside CML is also considered as part of this discussion. The outcomes inform and strengthen subsequent GROW conversations, ensuring they are grounded in broader strategic considerations and that development paths are transparent and well-founded. All steps are aligned with the national Dutch programme *Erkennen en Waarderen* that reforms how universities recognise and reward academic work. This programme has been implemented at Leiden University with *Academia in Motion* and hence gives implementation guidance, with criteria given at the university and faculty level. This way of working also addresses explicitly the recommendations made in the previous assessment period (see appendix G).

Recruitment: New vacancies for scientific staff are first discussed at the department level or within the support staff management team. Once a position is approved, the vacancy text is drafted and reviewed for budgetary alignment, HR requirements, D&I inclusive language before being published. Vacancies are posted internally first and then externally, ensuring an open and transparent recruitment process. The selection procedure consists of two interview rounds, each with a different focus and involving different combinations of staff members. For scientific positions, candidates in the second round are asked to lecture on their research. All staff may attend these lectures; if held online, the recording is deleted within 48 hours. Collegiality is an explicit topic of discussion during the interviews, alongside academic and professional criteria. More information on employment conditions and working at Leiden University is available on the university's website, *Working at Leiden University.*

Work-life balance: CML has a sickness absence rate of 2% (reference date 2025). This figure is in line with, or slightly below, the averages reported at Leiden University and across the Dutch universities. Such a rate suggests a generally healthy working environment in which staff feels supported and able to carry out their work sustainably. Leave data provide a similar picture. Managers encourage employees to use as much as possible of the available six weeks of annual leave, with the goal of maintaining a healthy work–life balance. Regular uptake of leave is encouraged as an important way to maintain wellbeing, and the available figures indicate that staff are able to take time off in a manner that supports rest and recovery.

To further support staff wellbeing and manage workload, CML has been developing a dedicated work–life balance tool, planned for completion in the first quarter of 2026. This tool expands on an existing monitoring scheme focused on teaching load, and is designed to help monitor working patterns, identify periods of high pressure, and assist staff and managers with planning and workload distribution. The tool will contribute to early identification of potential bottlenecks and help maintain a healthy and sustainable pace of work across the institute.

Code of conduct in integrity: To support a culture of integrity, CML follows the university-wide codes of conduct, see *Code of Conduct on Integrity.* All staff members are required to complete the Active Bystander training. In addition, all support staff participated in a "How to give and receive feedback" course in 2025, and this training will be extended to all staff from 2026 onward. These measures help ensure that collegiality, respectful communication, and responsible conduct are embedded in daily practice.

Social Safety: CML's response rate to the university's Employee Experience Survey 2025 was above average. Overall, CML achieved strong results in the survey, performing well on both an absolute scale and in comparison to other institutes within the Faculty and Leiden University. In general, CML staff is seeing the institute as a positive workplace with lots of freedom, pleasant colleagues, and connectedness. At the same time, there are points of concern, especially related to work pressure, career progression and promotion, and unclarity on processes and procedures. To maintain long-term safeguarding, CML has developed an integrated Occupational Health and Safety Management System and works according to a PDCA (Plan, do, check, act) cycle. Processes and procedures have been developed and aligned in consultation with

the Institute Council and in collaboration with the Occupational Health & Safety and Environmental Services, supporting continuous monitoring and improvement of social safety, workload and overall employee experience. In addition, CML has launched the programme on giving feedback in an intercultural context mentioned earlier.

In 2024, as the first institute within the Faculty, CML developed **Fieldwork Safety Guidelines,** which are regularly updated to reflect the latest insights on both physical and social safety. The guidelines have been taken up as benchmark within the Faculty (expected roll-out 2026) and are discussed and approved before field work starts. The person in charge of an offsite visit (teacher, research lead) can tailor the guidelines to specific circumstances, for example, the rules of the host organisation where relevant or cultural expectations. Furthermore, CML is developing an app-based check list for those performing fieldwork in which a risk mitigation table is filled iteratively by both research leads, PhD candidates and students (roll-out start of 2026).

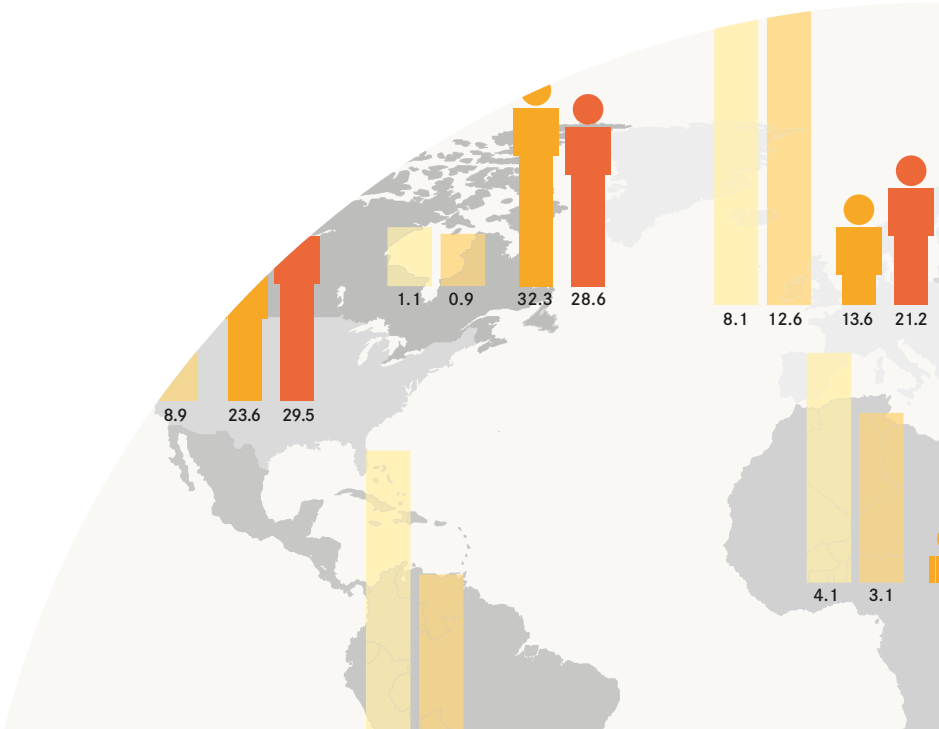
3.4 Open science & open data

CML actively supports the principles of Open Science, which increasingly shape research practice across disciplines. Over the assessment period, 91% of CML's peer-reviewed publications were published open access. At the institutional level, CML operates within the Data Management Regulations adopted by Leiden University in 2021.

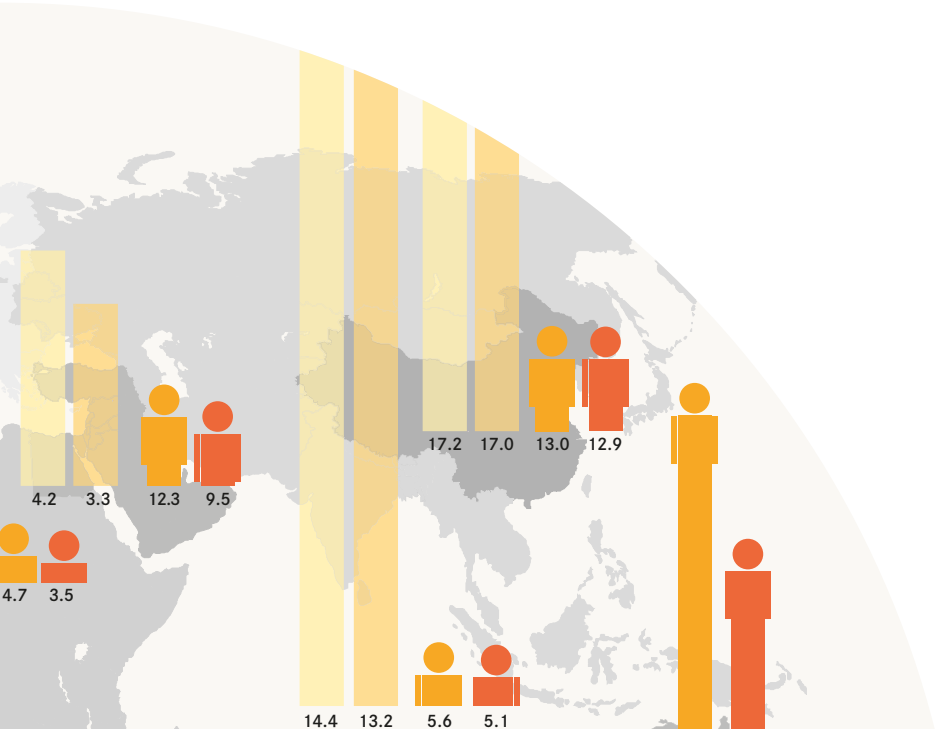
A formal statement describing how research data will be managed, documented throughout a research project for long-term management can be found at *https://www.library.universiteitleiden.nl/researchers/data-management/fair-data.* At the institute level, responsibility for research data management (RDM) is coordinated through designated contact persons, in alignment with faculty data stewards. Their tasks include maintaining awareness of current RDM policies, facilitating training, and supporting accountability within research teams. Oversight is embedded within the institute's management structure.

In line with UNESCO's concept of Open Science, CML's approach to Open Science extends beyond data accessibility and publication practices. In line with broader interpretations of Open Science, the institute aims to make research outputs accessible and meaningful to a wider audience. This includes engagement with journalists and media professionals, as well as the development of tools and resources that can be used by researchers, policymakers, and practitioners. Examples of such outputs are described in the impact section of this report.

CML researchers have developed and maintain a range of open-source software tools and databases that support transparency and reuse of scientific methods and data. The **Activity Browser** is an open-source LCA piece of software that provides a graphical user interface built on top of the *Brightway framework*, making it easier



to explore, model, and analyze LCA data and results. The *CML-IE-BE GitHub* repository hosts a collection of open-source LCA tools, impact assessment methods, and supporting resources developed by the CML Platform for environmental sustainability research and practice. The **Bestrijdingsmiddelenatlas** is an interactive Dutch online tool that visualises over 12 million measured concentrations of active substances from plant protection products and biocides in surface water across the Netherlands. CML co-developed **EXIOBASE**. This comprehensive global environmentally extended multiregional input-output (EEMRIO) database harmonises supply use and input-output tables across many countries to estimate emissions, resource use, and other environmental pressures linked to economic activity and final consumption. Currently we are looking further to develop **MARIO (IMF)** as a successor. Machine Learning researchers also developed a range of tools, that are now open access via third parties. For example, the chemicals of concern screening tool **(ZZS-Similarity Tool)** is now hosted at RIVM and the 2nd tiered (site-specific bioavailability) metal risk assessment tool **(PNEC-pro)**is now hosted at Deltares. CML improved plastics monitoring methods, which are now used by the Ministry of Infrastructure & Water and contribute to more efficient and accurate assessments. Public-facing initiatives, including **Unplastic Education** are open for schoolteachers.



4 Position in the research landscape

CML's strong position in the research landscape is reflected in a sustained increase in competitive external funding over the assessment period. The institute secured prestigious individual grants, including an ERC Starting Grant and Consolidator Grant, multiple VENI grants, and two VIDI grants, spanning research topics such as resource use, ecotoxicology, biodiversity dynamics, environmental DNA, and soil carbon sequestration (see Table E3.2 in Appendix A). In addition, CML has a broad portfolio of grants from different financial sources (see Table E3.2 in Appendix A). These include projects funded through Horizon Europe, Marie Skłodowska-Curie Actions, and INFRA calls as well as national grants like NWA-ORC, KIC. Together, these grants demonstrate CML's ability to contribute to and coordinate competitive research at national and international levels and provide a stable foundation for CML's research activities during the assessment period and beyond.

4.1 Environmental Biology department

Mission: The Department of Environmental Biology (CML-EB) advances quantitative understanding of how human activities impact ecosystem health, with a focus on biodiversity. Its research is driven by the urgent need to address societal challenges arising from environmental degradation and developing science-based concepts and tools that support nature-inclusive solutions useful to informed policy and sustainable development. CML-EB's overarching aim is to **assess the impact of environmental stressors across increasing environmental complexity and spatiotemporal scales, and to contribute to sustainable, nature-based, or design-based solutions** that directly address ecological risks and their societal consequences.

CML-EB performs research through mechanistic, quantitative investigations conducted at and across multiple scales of biological and ecological organisation. This across-scale approach spans from molecular to ecosystem functioning, and global biodiversity patterns, from urban systems to planetary boundaries. Moreover, CML-EB explores nature-based solutions to promote ecosystem resilience and integrates comprehensive risk assessments to guide sustainable decision-making. Explicitly, CML-EB researchers take the multi-stressor approach, including pollution from various sources, habitat destruction, climate change and overexploitation. CML-EB puts emphasis on modelling and lab-field extrapolations, explicitly making use of CML infrastructures like micro- & mesocosms.

Furthermore, satellite observations are used to support process research and to regionalise models. This way CML-EB researchers are grounded in process-based understanding and conduct research in field-representative settings that account for ecological dynamics and complexity. The research is integrative, quantitative, and often interdisciplinary, involving diverse species, communities, and ecosystems. To enable this, CML-EB develops and deploys a collection of advanced research tools:

- Eco(toxico)logical risk assessments to evaluate the potential harm of substances on ecosystems; risk assessments to evaluate the potential harm of substances on ecosystems;
- Environmental DNA (eDNA) methods to detect species presence and shifts in biodiversity;
- Spatial modelling to analyse ecological patterns;
- Geographic Information Systems (GIS) to assess environmental risks and evaluate spatial planning and conservation measures;
- Ex ante and prospective assessment tools and scenario assessments.

4.2 Industrial Ecology department

Mission: The Department of Industrial Ecology of CML (CML-IE) advances quantitative, system-based research to understand how human activities reshape society's material foundations and impact the environment. CML-IE's research is driven by the urgent societal challenges arising from **resource extraction and distribution, environmental degradation, and climate change**, and aims to provide **science-based tools, methodologies** and insights that support informed policy and sustainable development.

CML-IE maps and quantifies the **material and energy flows through society** — from critical raw materials, food systems, and built environments — at multiple scales, from individual products and processes to global supply chains, from urban systems to planetary boundaries. The overarching aim is to quantify and explore potential future environmental impacts of human activities across increasing complexity and spatiotemporal scales, and to contribute to develop solutions for a sustainable, circular economy that address resource challenges and their societal consequences. CML-IE applies a systems perspective grounded in thermodynamic principles and tested in real-world case studies that accounts for economic dynamics and complexity. The department evaluates and advances circular design strategies to promote resource efficiency, integrating comprehensive LCA studies to guide sustainable decision-making. CML-IE's integrated toolbox includes:

- LCA methodologies, evaluating environmental impacts across product lifecycles;
- Environmental Multi-Regional Input-Output analyses, tracking resource flows on different scale levels;
- MFA studies, monitoring the dynamic behavior of material stocks and flows through society;
- Ex ante and prospective assessment tools and scenario assessments, evaluating emerging technologies;
- Safe and Sustainable by Design (SSbD) frameworks, guiding new materials and chemicals at the earliest stages of innovation;
- Quantification of well-being within planetary boundaries;
- Multiple Criteria Decision Analysis (MCDA);
- Spatially explicit modelling.

Our goal is to translate quantitative science into actionable strategies that can guide circular economy transitions, effective evidence-based environmental policy-making, and sustainable and resilient resource management.

4.3 Research programmes

CML's research programmes are organised around five cross-cutting themes that reflect major societal and environmental challenges (Figure 1). These programmes operate across departmental boundaries and provide a framework for connecting fundamental research, methodological development, and applied analysis. Each programme is defined by a clear thematic focus and by the urgency of the underlying sustainability challenge.

Water: Staff within the water programme develops scientific concepts and analytical tools to assess and safeguard the chemical and ecological quality of aquatic ecosystems under changing environmental conditions. Research within this programme addresses multiple stressors and their interactions, supporting sustainable water use and biodiversity resilience. The urgency arises from accelerating human pressures on freshwater and marine systems, which increasingly exceed natural recovery capacities and require robust modelling and integrated assessment to guide action.

Urban: Staff within the urban programme integrate research on climate mitigation and adaptation, resource efficiency, biodiversity, food systems, and water management to support the development of sustainable and resilient cities. Our researchers view cities as interconnected socio-ecological-technological systems in which environmental quality and human wellbeing are closely linked. Rapid urbanisation has made cities a dominant locus of resource use and environmental impacts, including climate-related risks and public health challenges, underscoring the need for integrated urban solutions.

Future Food: Staff within the future food programme aims to strengthen the scientific

basis for sustainable food systems that provide nutritious food while reducing environmental pressures and enhancing ecosystem resilience. Research addresses interactions between food production, land use, nutrients, climate stress, and biodiversity across local to global scales. The urgency of this programme reflects the role of current food systems in driving land-use change, ecosystem degradation, and feedbacks that undermine long-term sustainable food security, highlighting the need for integrated and transformative approaches.

Resources: Staff within the resources programme focuses on the development and application of quantitative sustainability assessment methods to analyse resource and energy use and their environmental impacts across products, services, and infrastructure. The programme supports the identification of environmental hotspots, the evaluation of mitigation options, and the design of more sustainable systems, with relevance for sectors such as energy, industry, buildings, mobility, agriculture, and raw materials. The urgency of this programme lies in increasing global resource demand and growing environmental pressures along supply chains, which require system-wide, evidence-based analysis to inform timely sustainability transitions.

Biodiversity: Staff within the biodiversity programme focuses on developing scientific insights and approaches to halt biodiversity loss and to better understand biodiversity's role in addressing broader societal challenges, including climate resilience and sustainable development. Research in this programme examines biodiversity not only as a conservation objective, but also as a contributor to ecosystem functioning and human wellbeing. Ongoing biodiversity decline, often framed as a trade-off with economic and spatial development, creates an urgent need to identify synergies and pathways that support both ecological and societal objectives.

4.4 Scientific embedding: local, national, international levels

Many CML staff members contribute to the academic community through activities such as peer review, editorial board membership, and participation in national education committees as well as NWO and European grants (like ERC, Marie Curie ITNs) evaluating committees. In addition, many senior staff members hold ancillary positions to which they have been invited on the basis of their scientific expertise. A full overview is provided in Appendix C.

Local level: CML moved from an interfaculty institute to the Faculty of Science in 2009 and became one of its established institutes in 2014, alongside seven other institutes. Since then, CML has built **strong and regular collaborations across the Faculty**. CML works closely with the Leiden Institute of Advanced Computer Science (LIACS), including through the joint

appointment of Prof. Hai Lin and shared PhD supervision. With the Leiden Academic Centre for Drug Research (LACDR) we collaborate on research into the environmental safety aspects of drug discovery, for example through the NWA NanoMedNL programme. Several CML researchers participate in the Faculty's Artificial Intelligence network. With the Institute of Biology Leiden (IBL), collaboration spans both education and research. Within the Faculty (end 2025 onwards), sustainability research is further supported by the appointment of René Kleijn as **theme leader for Sustainability** and Peter van Bodegom as **theme leader for Biodiversity**.

CML has also established itself as initiator and leader of interdisciplinary collaboration. PhD projects are shared with institutes within the

Faculty of Science and with other faculties (primarily the Faculty of Social Sciences and the Faculty of Governance and Global Affairs), yet it is most often CML that conceives and coordinates these initiatives. This confirms CML's driving role in shaping interdisciplinary research agendas at Leiden University. Across faculties, colleagues consistently identify the institute as a reliable and inspiring partner, highlighting the quality and relevance of its research topics, the effectiveness of its collaborations, and the strong financial profile of its projects. For the past four years, CML has coordinated the university-wide ***Liveable Planet* programme**. Other initiatives such as the *Polderlab* and the *Buurtlab 070* illustrate the programme's role in linking faculties and creating interdisciplinary and transdisciplinary hubs. Interfaculty collaboration is also supported by University Professor Tukker, who connects research across Leiden University while directing the Centre for Sustainability (LDE CfS). This platform brings together CML's system-analytical expertise with technical innovation, sustainable product design, business modelling, behavioural sciences, and governance studies. These interdisciplinary collaborations are essential for analysing and shaping the transition toward a circular, carbon-neutral, and nature-positive society. Taken together, they illustrate the central position CML has developed within its research domain and within the broader academic ecosystem. Outside the Faculty, CML maintains a long-standing partnership with Naturalis Biodiversity Centre (NBC), home to the national biodiversity collections. Together with local biodiversity organisations including NBC, Hogeschool and the municipality of Leiden, CML forms the core of the Leiden Biodiversity Network. This network supports joint research efforts, including collaborations through Prof. Koos Biesmeijer (Naturalis Scientific Director and professor at CML) and Dr. Jan Macher (researcher at Naturalis, and guest researcher at CML).

National level: CML is an active member of the national Environmental and Earth Sciences (EES) community, which organises the annual conference. The EES community brings together researchers from WUR, UvA, VU, UU, Radboud University, and Leiden University, covering the full spectrum of Earth, planetary, and environmental sciences. The field is internationally competitive and highly collaborative. CML contributes to this network in several ways: Prof. Vijver serves both on the EES Working Group and on its Board, and Dr. Mogollón helped shape the community's strategic plan together with colleagues from various universities. CML is involved in numerous research platforms, among them NERN, GROW, NWO committees, and the BiodiversityXL initiative. The latter connects KNAW institutes, Naturalis, and universities within the Raad van Biologie (Biology Council). Prof. Erisman serves two days per week as chair of the Dutch Climate Council (Wetenschappelijke Klimaatraad). Prof. Van Bodegom held a one-day-per-week endowed chair in sustainable horticulture (2020–2024), linking CML to innovation in the greenhouse sector in the Dutch Westland region and in Morocco. CML has several guest research contracts with NIOO and multiple staff work at TNO part-time. Prof. De Snoo, as director within the KNAW, provides an additional connection to the Academy's networks and institutes. CML maintains close collaborations with the National Institute for Public Health and the Environment (RIVM), supporting the translation of research into policy advice. Prof. Peijnenburg plays a central role in bridging CML and the RIVM on chemical safety. Several RIVM researchers hold guest positions at CML, including Dr. Pim Wassenaar (computational ecotoxicology) and Dr. Marieta Braks (vector-borne diseases and landscape

dynamics). CML also collaborates extensively with the Netherlands Environmental Assessment Agency (PBL). PBL and CML have staff members with joint appointments, namely Dr. Barbarossa holds a one-day-per-week position at PBL, while Dr. Van Oudenhoven and Dr. Remme supervise Dr. Veerkamp's work on urban nature at CML. Prof. Vijver's expertise is drawn upon within various government and parliamentary advisory boards, and staff members more broadly contribute to policy-facing processes at national level. For more details on ancillary positions connecting CML's researchers to science and society more broadly are provided in Appendix C.

International level: In Europe, CML is an active member of the UNA Europa alliance since January 2023. Within this framework, formal collaboration agreements with partner universities enable joint research initiatives, researcher exchange, and coordinated participation in European funding programmes. CML is an active partner in several Marie Skłodowska-Curie doctoral and postdoctoral training networks, contributing to structured international training environments and sustained collaboration between institutions (see Table E3.2 on research grants in Appendix A). Prof. Erisman served on the European Soil Mission Board for the past 4 years advising the European Commission on Soil policies and developing the Horizon research program on soils. Prof. Tukker has been appointed president of the International Society of Industrial Ecology, the key global scientific society in IE (April 2025). Beyond these alliances, CML maintains long-standing bilateral collaborations with universities and applied research organisations across Europe. These include joint PhD supervision and research programmes with applied research institutes in Belgium (e.g. environmental assessment and chemical safety), collaborations with German research centres on industrial ecology, circular economy modelling, and energy transition pathways, and joint doctoral supervision with Swiss universities of applied sciences focusing on sustainability metrics and systems analysis. CML also collaborates with European technical universities on circular materials, safe-and-sustainable-by-design approaches, and urban sustainability, and works with Nordic partners on urban nature and spatial planning. Together, these collaborations support shared methodological development and coordinated research on industrial ecology, circular economy, urban sustainability, soil and water quality, and environmental risk assessment. Regular collaboration with the European Joint Research Centre (JRC) contributes to the development of shared datasets, modelling frameworks, and policy-relevant analyses at the European level. CML has part-time positions for its staff at Oxford Martin School on food and climate change impacts. International partnerships also extend beyond Europe through joint doctoral degrees and long-term collaborations with universities in Asia and Africa, supporting capacity building and the co-development of sustainability research agendas in diverse socio-environmental contexts.

CML staff also holds a visible position in global **international scientific and United Nations networks** (see appendix C, for instance Hoekstra, Van der Voet, Kleijn). The institute contributes to international scientific societies, expert panels (UN International Resources Panel and UNECE), flagship reports (ADB Aid for Development report, UNEP Global Resources Outlook) and assessment processes related to resource governance, biodiversity, sustainability metrics, and environmental impacts. CML has co-founded and actively contributes to thematic research networks such as the Prospective Life Cycle Assessment network and the Plastic Footprint Network, which address emerging methodological challenges and strengthen international coordination in sustainability assessment. Through contributions to UN-affiliated platforms and international assessment bodies, CML research informs debates on circular economy transitions, wellbeing and Beyond-GDP indicators, and sustainability within planetary boundaries. These roles reflect recognition by international peers and provide channels through which CML's research contributes to **global science–policy interfaces** (e.g. IPCC and IPBES). In addition to research collaboration, CML contributes to the scientific community through academic service and network building. Staff members serve as editors and reviewers for international journals, participate in scientific committees, and contribute to international standard-setting initiatives.

5 Evidence

5.1 Research quality

During the assessment period (2020–2025), CML produced 725 peer-reviewed publications that are included in the CWTS citation analysis (Appendix B, Table B1). Annual output remained stable. In addition to journal articles, CML developed datasets, modelling tools, software packages, and methodological frameworks that support sustainability assessment, biodiversity monitoring, and environmental risk analysis.

A keyword co-occurrence analysis of publications (Appendix B, Figure B2) identifies three major thematic domains: (1) environmental toxicology and risk assessment (e.g. toxicity, concentration, nanomaterials, and fate); (2) biodiversity, soil and ecosystem functioning (e.g. plant, soil, diversity, habitat, and interactions); and (3) system-level sustainability assessment and scenario modelling (e.g. emissions, environmental impact, consumption, and policy).

The scientific use of CML's research by peers is evidenced by strong citation impact and extensive collaboration. Appendix B (Table B1 and B3) shows general bibliometric statistics and trends. The indicators show that CML publications are cited well above global reference levels. The Mean Normalised Citation Score (MNCS) is 1.79, indicating that publications are cited 79% above the global field-normalised average. CML publication output demonstrates strong performance across journal tiers (see Appendix B, Table B3). The proportion of publications in the top 10% most cited globally is **23%** (world benchmark: 10%), and 4% are in the top 1%. This reflects both excellence and reach in CML's scientific contributions. Collaboration is structurally embedded: 92% of CML publications involve inter-organisational collaboration and 74% involve international co-authorship. Internal collaboration has increased over time, with the average number of CML co-authors per publication rising from 0.96 (2020) to 1.63 (2024). This reflects the emerging integration across departments and research programmes. The authorship data further show a rejuvenation of the research profile: as mentioned earlier, the average academic age of CML-affiliated co-authors declined from 12 years in 2020 to 7 years in 2024. This indicates the successful integration of early-career researchers into high-quality publication output.

Research outputs span both disciplinary and interdisciplinary journals and cover methodological development and applications to complex sustainability challenges (see Appendix B, Figure B2). These research products are embedded in long-term research lines rather than isolated projects. This demonstrates continuity and cumulative knowledge development across departments and programmes.

Publications increasingly involve collaboration across departments within CML as well as with national and international partners. The institute thus functions as an active hub in broader research networks. The combination of methodological innovation and application across multiple domains enhances the uptake of CML's work by peers working in environmental science, sustainability assessment, ecology, and related fields. Research outputs are frequently used as reference points in follow-up studies, methodological extensions, and comparative analyses, demonstrating their value beyond the originating projects.

CML's research quality is further demonstrated through success in competitive grant acquisition, leadership in large collaborative initiatives, and invitations to contribute to high-profile scientific activities. During the assessment period, CML researchers have secured a range of prestigious individual and collaborative grants, including

ERC, NWO, Horizon Europe, and infrastructure funding. Strategic investments in shared research infrastructure and large-scale collaborations have strengthened CML's visibility and positioning within national and international research landscapes. Researchers are regularly invited to present keynote lectures, participate in expert panels, and contribute to international scientific assessments and advisory bodies, reflecting trust in their expertise and standing within the scientific community.

Policy citation data reinforce the external uptake of research: 192 CML publications were cited in 658 policy documents during the period, demonstrating that scientific outputs are used beyond academia (see Appendix B, Figure B4 and the next paragraph).

5.2 Societal impact

Research at CML generates societal impact across multiple domains. In this section, we present three illustrative case studies from the period 2020–2025 that demonstrate how CML research contributes to policy, practice, and public debate in the areas of soil and water quality, circularity and wellbeing, and sustainable land use and food production.

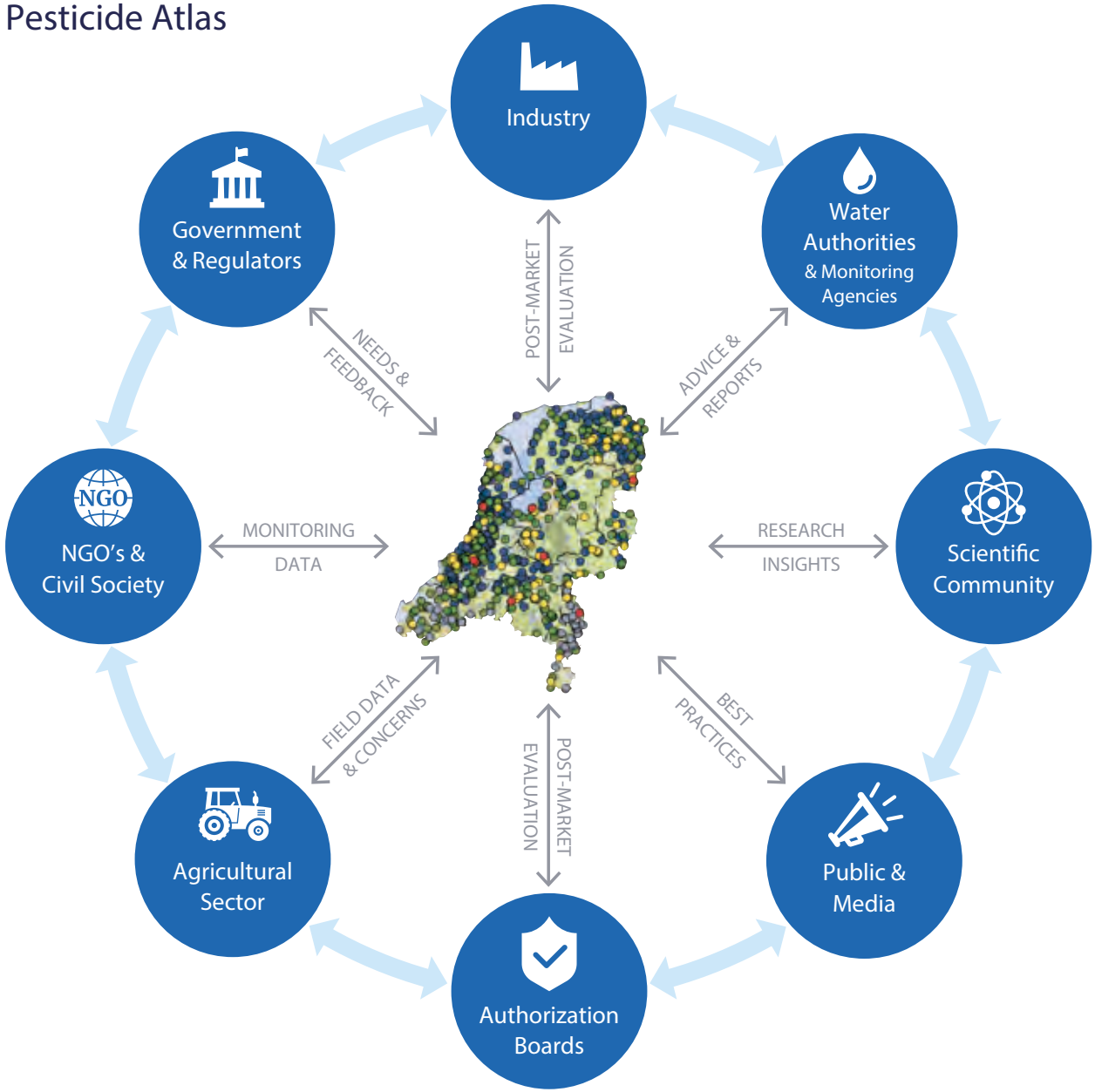


Figure 4: The Pesticide Atlas (www.bestrijdingsmiddelenatlas.nl) as a science–policy interface. Monitoring data on pesticide concentrations link researchers, regulators, water authorities, industry, civil society, and the agricultural sector, enabling post-market evaluation of pesticide authorisations and supporting evidence-based environmental policy.

Example 1: Soil and water quality: evidence-based regulation and environmental protection.
CML has established a strong impact profile in environmental toxicology, pesticide monitoring, and nitrogen policy by providing quantitative evidence that directly informs regulation, enforcement, and public debate. A flagship example is the **Bestrijdingsmiddelenatlas / Pesticide Atlas**, (see Figure 4), which has become a central instrument in Dutch pesticide policy. Since 2024, the Atlas has been formally adopted by the authorisation board CTGB for post-market evaluation of pesticide approvals. It is used in regulatory processes (from making use of monitoring data in evaluations, to discussions on statistics), parliamentary debates (16 times mentioned within Staatscourant in 2024-2025, Kamerstukken II 27 858 nr. 579; nr. 653; nr. 633, Kamerbrief 8 May 2024) and many national policy documents related to policy evaluations (e.g. EDG, GGDOE, UPGW, Green Deal's-zero pollution). The Atlas is now seen as a blueprint for other EU countries. This demonstrates a clear and traceable impact pathway from scientific monitoring to decision-making. Civil society organisations and health groups also use the Atlas as an evidence base in public debates on pesticide exposure and environmental standards (e.g. the court cases related to lily bulb farming in Drenthe, Meten = Weten, Urgenda, PAN, GGZ, NVWA).

CML also uses experimental and monitoring infrastructure that enables ecologically realistic assessment of multiple stressors. **The Living Lab mesocosm facility**, built from crowdfunding money, received national hub status by receiving the NWO infrastructure money (2025). Through national infrastructure initiatives, this facility is now embedded in broader research networks, and this ensures sustained societal value beyond individual projects. The facility allows the combined effects of pesticides, nutrients, and other pressures to be studied under near-natural conditions. Research conducted at this facility has contributed to regulatory decisions including pesticide bans (adding data into the banning of the neonicotinoids; 2020-2022), improved understanding of ecological risks of emerging substances (advanced materials and plastics), and the adoption of eDNA as a sensitive tool for detecting community-level effects.

Within this broader multi-stressor perspective, **nutrient pollution and nitrogen** in particular form a key focus of CML's policy-relevant research. Following the 2019 ruling of the Dutch Council of State that invalidated the **Programmatic Nitrogen Approach (PAS)**, CML research contributed to reframing nitrogen governance by clarifying the links between emissions, deposition, ecological impacts, and policy feasibility. CML with OntspannenNederland.nl laid the basis for the Dutch nitrogen policy by minister Van der Wal including a budget, clear goals and regional policies. Quantitative analyses supported the shift from a deposition-oriented to an emission-based policy logic and informed the translation of ecological targets into emission reduction objectives. These insights contributed to national policy design, including the allocation of substantial public funding for nitrogen mitigation within the National Programme for Rural Areas.

CML's role in science–policy integration in this domain is further reflected in its contribution to national climate governance. The **Netherlands Scientific Climate Council** (Wetenschappelijke Klimaatraad, WKR) is chaired by a CML professor to ensure that independent scientific evidence on climate change, its causes and effects is translated into recommendations for Dutch climate policy. This role complements CML's contributions to international assessment bodies and illustrates the institute's capacity to connect environmental science with strategic policy advice at the highest national level. CML's work on soil and water quality is further translated into practice through **analytical tools that are now hosted and used by public authorities**. Examples (see also paragraph 3.4) include the chemical screening tools at RIVM, site-specific metal risk assessment tools at Deltares, and improved plastics monitoring methods applied by the Ministry of Infrastructure and Water Management. Together, these activities illustrate how CML integrates monitoring, experimentation, and modelling to support evidence-based environmental regulation and long-term protection of ecosystems and human health.

Example 2: Circularity, resilience, and wellbeing: shaping system-level transitions. CML contributes to international and European debates by developing models, indicators, and scenarios that move beyond conventional economic growth metrics. Through leadership in initiatives such as **WISE Horizons**, CML has helped shape the international ***Beyond-GDP*** **agenda** by integrating wellbeing, inclusion, and sustainability into economic assessment frameworks. Dr. Hoekstra is particularly noteworthy to mention. He was a member of a select panel of experts and spoke to the UN General Assembly on Beyond-GDP (2024), an event that has led to the creation by the Secretary General of a High-Level Expert Group on Beyond-GDP. CML researchers frequently contribute to such high-level advisory processes (both EU and UN), support the development of alternative accounting standards, and engage with international governance forums. This work positions CML as an agenda-setting actor in societal debates on post-growth economics, strategic autonomy, and long-term societal resilience. In parallel, CML plays a prominent role in research on **critical raw materials and circular economy strategies** (see Figure 5), addressing availability, geopolitical dependencies, and environmental impacts of materials essential for the energy transition. Contributions to EU policy frameworks, UN resource assessments, and international classification standards illustrate how CML's quantitative sustainability modelling directly informs resource governance and sustainability strategies.

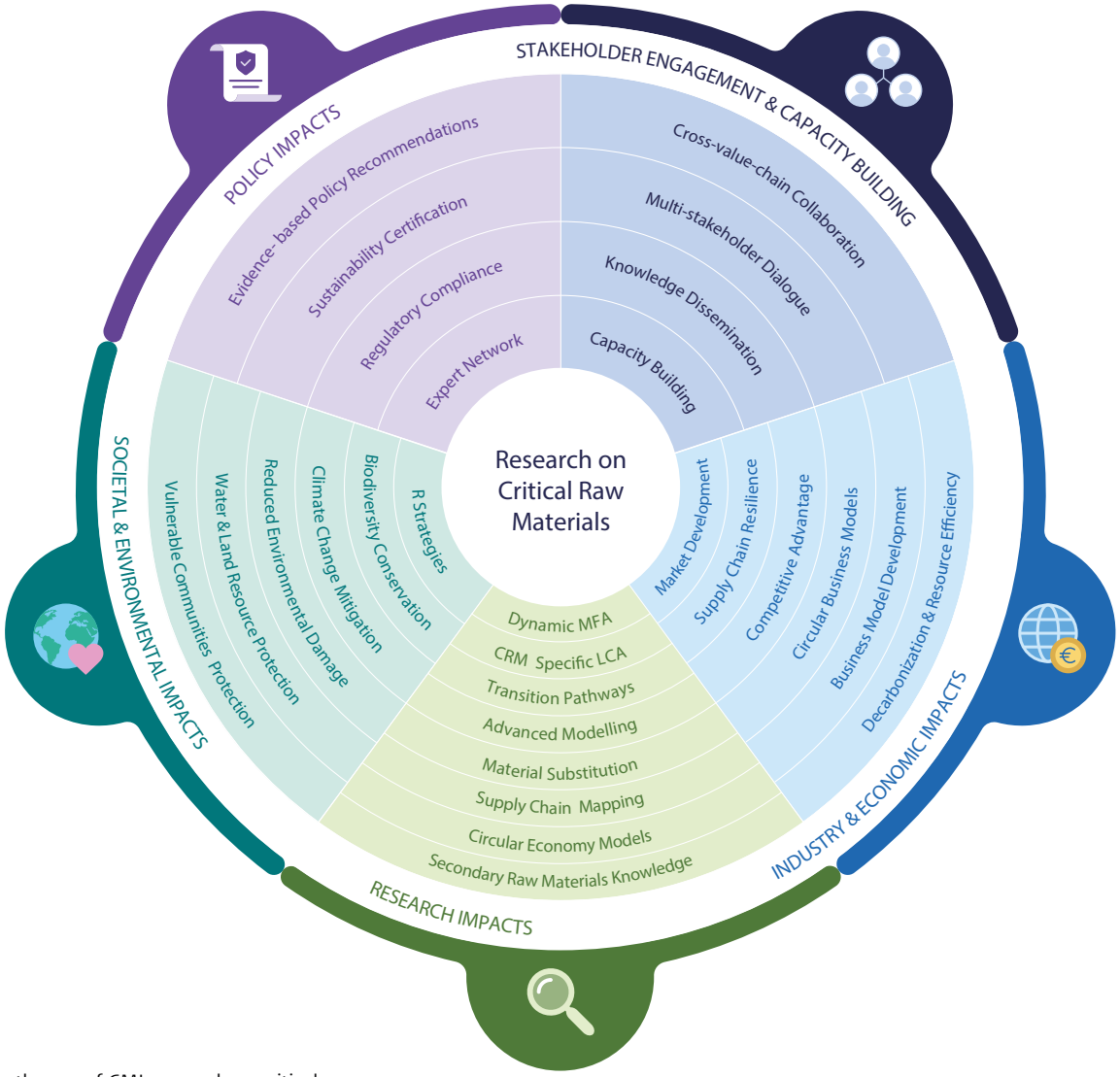
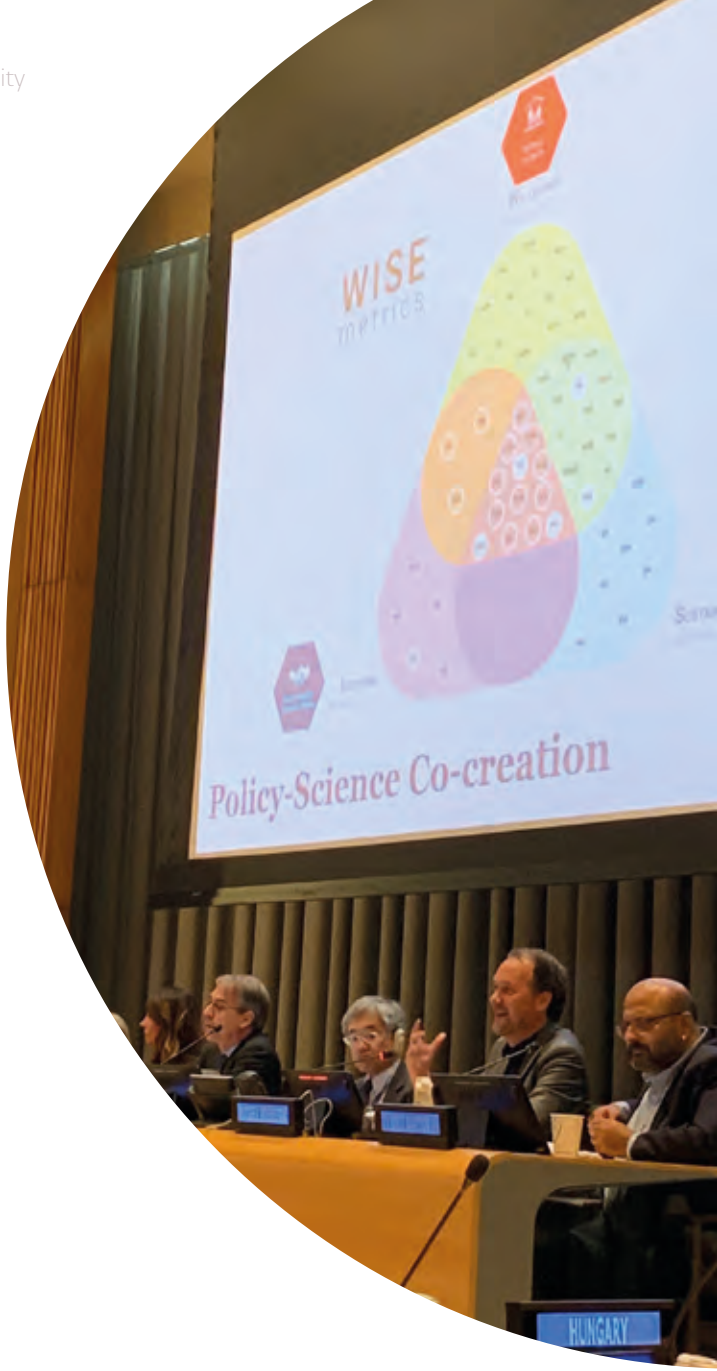
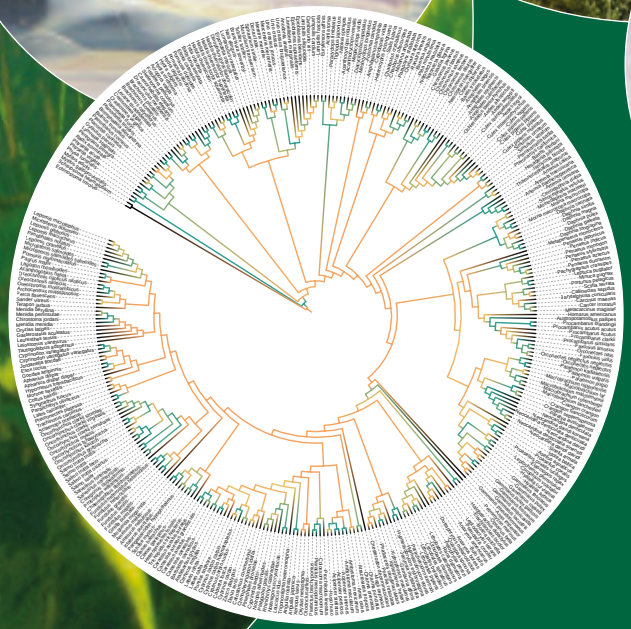


Figure 5: Impact pathways of CML research on critical raw materials. The figure illustrates how methodological research—such as dynamic material flow analysis, circular economy modelling, and supply chain analysis—translates into research outputs, industrial and economic applications, policy advice, and broader societal and environmental impacts.

Example 3: Sustainable land use and food production: integrating biodiversity, climate, and society. CML contributes to this transition through a combination of scientific analysis, living labs, and policy engagement. Living labs, such as **Polderlab** and **Buurtlab 070**, connect researchers with farmers, residents, students, and local authorities to co-develop practical approaches to biodiversity recovery, nutrient management, and sustainable livelihoods. These initiatives translate research insights into locally grounded solutions while informing broader policy debates. CML's **food systems research** informs national and international policy discussions (Leiden studies on impacts of diets were mentioned four times in Dutch Parliamentary discussions in 2025) on dietary change, agricultural emissions, and land-use scenarios. Studies conducted for public authorities and international organisations contribute to assessments of sustainable diets, agricultural policy options, and environmental impacts of food production. At the global level, CML research feeds into international reports on food security, farming systems, and environmental protection.

Beyond these examples, and others across all impact themes, CML operates within dense networks of academic, governmental, and societal partners. Its **analytical tools**—including life cycle assessment, material flow analysis, environmentally extended input–output analysis, and eDNA monitoring—are widely used by governments, industry, NGOs, and international organisations to support evidence-based decision-making. **Public engagement and education** complement these impact pathways. Initiatives such as public-facing tools, educational programmes, MOOCs, and media engagement support transparency, public understanding, and trust in science. **Educational programmes** serve as an important link through which research insights inform the training of future professionals operating at the science–policy–society interface.





6 SWOT analysis

STRENGTHS

- Development of quantitative tools which translate into actionable strategies for sustainability, circular economy, and environmental impacts, shown in policy-oriented products and intersectoral collaborations.
- CML's strong capability in each of the components needed to inform decision-making, (i) data gathering, (ii) alternatives development, (iii) alternatives assessment (impacts and benefits), (iv) trade-off management to recommend solutions.
- The institute benefits from a highly international and diverse staff profile and a strong culture of collaboration and mutual support, which facilitates interdisciplinary research and knowledge sharing.
- Steady inflow of funded research projects and strong track record in project acquisition. Flexible, adaptive, and creative approach to research topics across departments, enabling innovative framing and efficient use of financial resources (covering 2nd, 3rd and 1st money streams).
- Early-career researchers, including PhD candidates and postdoctoral researchers, have strong visibility within their scientific communities, particularly in areas such as industrial ecology and ecotoxicology.
- Governance and quality assurance structures are clearly defined, including transparent management responsibilities, institute-wide talent review processes ('vlootschouw'), and structured PhD support and development procedures.
- CML has a dynamic and innovative organisational culture that encourages new ideas — in research questions, teaching approaches, and operational support. Recent examples that we take these efforts also at operational support includes the development of a fieldwork application and the CML-initiated Leiden University Support Bot (LUS-Bot), designed to improve administrative support for staff and students.

WEAKNESSES

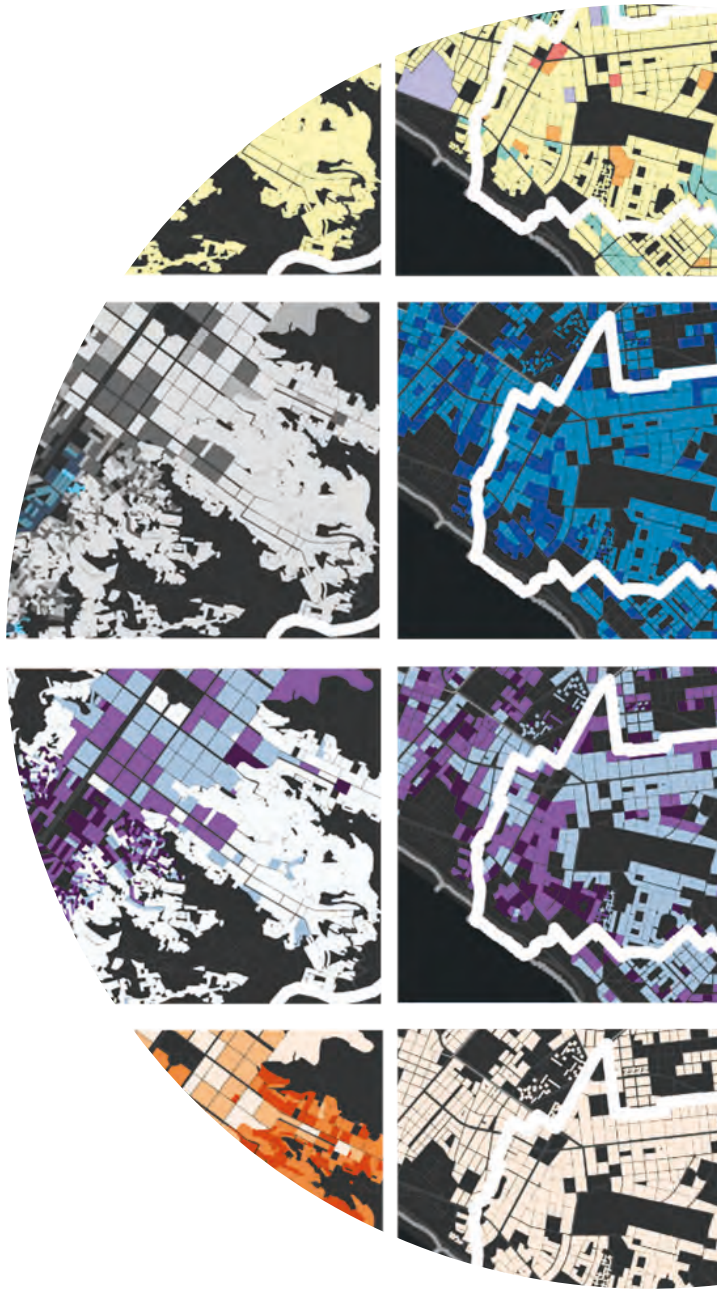
- Recruitment at the senior level remains challenging, resulting in a relatively young staff profile and limited capacity to fill some senior academic and leadership roles. We thus invest in training and development.
- The limited proportion of Dutch-speaking staff may reduce the institute's visibility and influence in national policy processes, advisory bodies, and administrative roles. Within the career paths emphasis is given to learn the basics of the Dutch language.
- Physical constraints, including limited laboratory and office space, restrict the pace at which research activities and staffing can expand.
- Rapid growth has increased demands on management and coordination, requiring continued investment in organisational structures and leadership capacity.

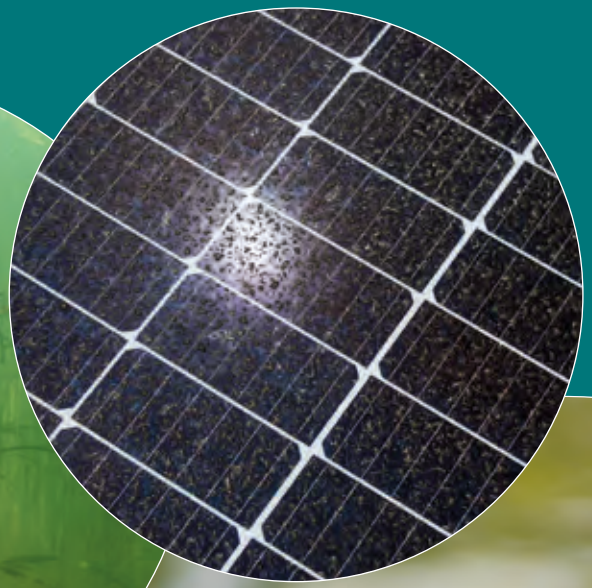
OPPORTUNITIES

- CML's unique position at the interface of natural capital, socio-economic systems, and quantitative assessment offers clear potential to further differentiate the institute within international sustainability research.
- The growing urgency of environmental and societal transitions creates demand for systems-based, evidence-informed research aligned with themes such as resilience, strategic autonomy, wellbeing within planetary boundaries, and health impacts of the triple planetary crisis. These strengthen the relevance of educational initiatives such as the BSc *Science for Sustainable Societies* and CML's two MSc programmes *Industrial Ecology* and *Governance of Sustainability*, which directly reflect these challenges.
- The South-Holland region offers opportunities for strengthened collaboration in areas such as circular economy, urban sustainability, and life sciences, including partnerships with industry, Hogeschool and public institutions for different grant collaborations, and lifelong learning trajectories.
- Advances in artificial intelligence and data science open new possibilities for sustainability modelling, scenario analysis, and integrated assessment of complex systems e.g. the horticulture sector, the petrochemical cluster in Rotterdam and the space cluster around Leiden. We currently (2026) start a dedicated investment by active collaboration and a joint position with LIACS and the CML computation teams are also skills-wise come together.

THREATS

- CML's physical location outside the main Faculty of Science buildings increases the effort required for day-to-day interaction and collaboration and intensifies competition for limited laboratory, computational, and experimental space. In later future, the Faculty tries to repair this by planning a new building.
- Increasing societal expectations for rapid and visible impact, combined with fluctuations in public trust in science, place growing demands on researchers' time and capacity for engagement.
- Declining student interest in interdisciplinary sustainability programmes across the Netherlands likely limits enrolment in CML-related degree programmes, with potential implications for long-term educational capacity.




7 Resilience to the future: outlook 2026-2031

7.1 Strategic vision

CML builds its future vision on a strong and well-established foundation of interdisciplinary excellence. Its long-standing leadership in Industrial Ecology in combination with the innovative methods and concepts developed in Environmental Biology positions the institute as a global authority in quantitative sustainability science. Looking ahead, CML will further consolidate its position as a global leader in sustainability science by advancing an integrated research agenda that connects **technological innovations, (geo-) economic systems, ecosystem health, and societal wellbeing and resilience** within the constraints of **planetary boundaries**.

The Environmental Biology department will continue to advance quantitative, systems-based understanding of how human activities affect ecosystem health and biodiversity. Research combines mechanistic approaches across biological scales—from molecular and organismal responses to ecosystem functioning—with field-based observations and experimental systems. This enables improved prediction of ecological impacts of environmental stressors, supports lab–field extrapolation, and contributes to the development of nature-based solutions and strategies aimed at reversing biodiversity loss across ecosystems.

The Industrial Ecology department will further develop quantitative approaches to analyse how human activities shape material and energy flows and their environmental consequences. Its research addresses societal challenges such as resource scarcity, environmental degradation, and climate change by developing robust analytical tools that support circular economy transitions and sustainable resource use. Particular emphasis will be placed on analysing impacts across scales—from products and urban systems to global supply chains—while integrating considerations of planetary boundaries and societal wellbeing.

To support these ambitions, the institute will continue to invest in advanced assessment tools, computational infrastructure, and global databases, strengthening its capacity to analyse complex socio-technical and socio-ecological systems. Developments in artificial intelligence and large language models present significant new opportunities for modelling, data integration, and environmental assessment. CML is actively pursuing these opportunities: a strategic retreat in April 2026 will mark the start of a structured process of exploration and investment, to be followed by targeted initiatives in the years ahead. In terms of long-term viability, CML expects continued growth in modelling and computational research. Supporting this growth will require specialised data engineers, technical support for high-performance computing and AI, and expanded computational infrastructure. As part of this effort, we will further invest in computational research, including strengthening links with LIACS, potentially through joint staff appointments.

AI adoption is already visible at the operational level: CML has developed a Leiden University Support Bot providing around-the-clock responses to administrative questions on eligibility, budgets, and regulations, as well as a mobile fieldwork check application — tools that are now being made available to other institutes at Leiden University.CML will continue to invest in the development and renewal of its educational programmes to ensure that they remain scientifically rigorous, socially relevant, and attractive to students. We will continue to strengthen the collaboration with our LDE partners, and universities of applied sciences (HBO) institutions in the area. Teaching will be closely aligned with ongoing research and emerging global sustainability challenges and

continue to follow our research strategy closely. Furthermore, the institute anticipates expanding its laboratory capacity, together with the necessary technical support staff and data infrastructures and bioinformatics. At present, space constraints remain a challenge; however, discussions are ongoing at both the Faculty and University levels to address this issue.

Building on its established strengths in Industrial Ecology and Environmental Biology, CML will further develop research approaches that address emerging sustainability challenges. These approaches will increasingly **integrate socio-ecological modelling, socio-technical modelling and analyses of the societal dimensions of sustainability**. Examples of focus areas include:

1) Safe-and-Sustainable by Design (SSbD). CML will further embed the SSbD framework across its research programmes to ensure that new materials, chemicals, technologies, and management strategies are safe for human health and ecosystems from the earliest stages of design. This is built up from ex ante Life Cycle Analysis together with prospective Risk Assessment instruments and multicriteria analysis. Within this framework, impact assessment is an integral component, that enables design criteria to be refined while explicitly addressing uncertainties arising from data limitations and incomplete process understanding. CML will continue to develop quantitative methods and modelling tools that support robust decision-making under uncertainty.

2) One-health and biodiversity-positive solutions The One Health framework recognises that human, animal, and environmental health are closely linked and interdependent, requiring collaborative and multidisciplinary approaches to manage threats and environmental challenges. This perspective is central to CML's research agenda. In urban systems, CML's research will assess the costs, benefits, and distributional effects of greening and nature-based solutions, such as green roofs and multifunctional green spaces. As well as evaluate how these interventions influence urban ecosystems, material and energy flows, climate mitigation, health and wellbeing versus trade-offs on vector-borne diseases and "de-services" supporting integrated long-term urban sustainability strategies. In rural areas, CML aims to anticipate and mitigate unintended impacts of agrochemicals, urban materials, and emerging pollutants on ecosystems while supporting innovations that reduce emissions, enhance ecosystem multifunctionality, and advance circular and regenerative systems (e.g. lowering nitrogen surpluses and pesticide use). Analyses will quantify trade-offs and synergies between productivity, environmental pressures, climate mitigation, and resilience to support sustainable food production in rural and peri-urban areas.

3) Wellbeing indicators for sustainability transitions. Building on analytical traditions already present at the institute, such as quantitative sustainability assessment and material-flow–based approaches and environmental systems analysis, we advance the development of wellbeing indicators that move beyond purely economic measures of progress. This work extends established modelling frameworks to new domains by applying similar tools to questions of economic systems, wellbeing, and sustainability. In doing so, the research creates an important bridge between environmental science, economics, and public policy. This conceptual development also provides a crucial link between environmental integrity, biodiversity, and socio-economic development. Integrating these dimensions into wellbeing indicators enables a more comprehensive understanding of societal outcomes, including social cohesion and long-term quality of life.

7.2 Adaptive, collaborative and viable

The institute reaffirms its commitment to maintaining human wellbeing within planetary boundaries and to shaping sustainable futures in which **biodiversity, sustainable resource and energy systems, resilient food systems, vital soil & healthy water systems and liveable cities** are integral to societal progress. The five cross-cutting research programmes—biodiversity, future food, water, resources, and urban—are designed to be flexible and responsive to both societal and fundamental challenges. They are intended to adapt to emerging priorities, such as soil health, energy transitions, and other developments required for a sustainable new economy. CML's future strategy is characterized by coherence, adaptability, and collaboration. CML will further strengthen

collaboration across departments and research programmes. This prevents future fragmentation as the institute grows, and to ensure that tool development and applied research remain closely connected.

Our research provides a strong basis for strengthening the **science-policy interface** which requires multifaceted research perspectives that collaboration can deliver. CML's adaptive capacity is supported by its interdisciplinary research structure, strong national and international networks, interdisciplinary education, and close alignment between research and education. Collaboration with academic partners, policy makers, industry, and civil society remains an essential element of the institute's approach, enabling scientific insights to inform decision-making and societal debate. These collaborations are embedded within CML's research programmes and supported by institutional coordination rather than relying solely on individual initiatives. Also, Lifelong Learning education and collaboration within the region (South Holland and maybe beyond) will be explored.

CML organisation and connection. For the period 2026–2031, CML's organisation focus is on consolidation, targeted growth, and effective implementation. The central objective is to strengthen CML's ability to deliver high-quality research, education, and societal engagement in a coherent and sustainable manner. Viability in the coming period depends on maintaining a balance between ambition, capacity, and resources. CML will continue to engage with societal and policy actors in a selective and focused manner, prioritising areas where its expertise provides clear added value. This approach supports societal relevance while safeguarding academic independence and ensuring that expectations regarding impact and engagement remain compatible with available staff time and organisational capacity.

Sustained growth requires clear internal coordination, transparent decision-making, and manageable workloads. Departmental visions, cross-programme leadership, and institute-wide coordination mechanisms will be further developed to support coherence, safeguard research quality, and reduce reliance on informal structures. Leadership development across career stages will continue to receive focused attention, ensuring continuity and organisational resilience. We will keep staff trained to be flexible, also via lifelong learning for scientific and support staff (Appendix F). Most importantly, we will keep the community together by paying close attention to what motivates each of us and by providing a pleasant and inclusive work environment. We believe that understanding one another—and what drives us—is essential. Successfully navigating change depends not only on having a solid plan, but also on how well we think and act together.

The projected increase in staff from approximately 140 FTE in 2024 to around 170 FTE (including paid PhD candidates) by 2030 will be aligned with educational needs, available infrastructure, and supervisory capacity. Staffing decisions will be tied explicitly to teaching responsibilities, research programme priorities, and long-term viability, rather than short-term funding opportunities alone. Maintaining a balanced distribution of effort across research, teaching, and societal engagement will remain a guiding principle. This means that scientific staff is projected with 4 PhD students, and consolidation can also be gained with choosing university teachers. Education will remain closely connected to research. The consolidation of the BSc Science for Sustainable Societies and the continued development of the MSc programmes will strengthen the alignment between teaching and ongoing research. Staff appointments and research priorities will explicitly take educational contributions into account, ensuring that growth in research capacity is matched by educational quality, continuity, and student support.

We look confidently forward to the future with deep passion for research, education, and societal engagement in all its forms.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Katwijk


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Best Publication

List of Appendices

Appendix A Mandatory tables

Table E1: Categories of evidence for the quality domains of research quality and relevance to society

Assessment Dimension	Research Quality	Societal Relevance
1. Demonstrable research products	**Evidence**: - 725 peer-reviewed publications - MNCS 1.79; 23% top 10%; 4% top 1% - 91% Open Access - Methodological advances in LCA, MFA, EEIO, SSbD, eDNA - EXIOBASE; open-source tools; SEFAP / Levend Lab infrastructure **Targets (2026–2031)**: - Maintain citation impact above world average (MNCS ≥1.7) - Further integrate SSbD, techno-economic modelling and biodiversity across programmes - Expand shared research infrastructure and computational capacity	**Evidence**: - 192 publications cited in 658 policy documents - Bestrijdingsmiddelenatlas adopted by CTGB - Nitrogen modelling informing policy redesign - Contributions to EU & UN resource governance - Tools adopted by RIVM, Deltares, ministries **Targets (2026–2031):** - Strengthen systematic documentation of policy uptake - Expand application of monitoring and modelling tools in EU-level initiatives - Further embed wellbeing and planetary boundary indicators in policy-relevant research
2. Demonstrable use of research products	**Evidence:** - 92% inter-organisational collaboration; 74% international co-authorship - Increasing internal co-authorship (0.96 –> 1.63) - Strong integration of ecological and techno-economic domains - Joint PhD programmes and Marie Curie networks **Targets (2026–2031):** - Further strengthen cross-departmental integration via research programmes - Increase long-term strategic EU consortia participation - Consolidate international PhD and postdoc networks	**Evidence:** - Uptake in nitrogen and climate governance - WISE Horizons shaping Beyond-GDP debate - eDNA and risk models used in environmental monitoring - Living labs co-developing regional solutions **Targets (2026–2031):** - Expand urban and food system applications of integrated modelling - Increase structured engagement with ministries and EU missions - Scale living lab approaches where scientifically justified
3. Demonstrable marks of recognition	**Evidence:** - ERC (Starting/Consolidator), VENI/VIDI awards - NWO infrastructure (SEFAP), Horizon Europe Pathfinder - Leadership roles in ISIE and scientific networks (e.g....) - Editorial and committee memberships **Targets (2026–2031):** - Strengthen internal progression to senior positions - Maintain competitive ERC/NWO/Horizon acquisition - Enhance international leadership in SSbD and planetary-boundary research	**Evidence:** - Chairing Netherlands Scientific Climate Council (WKR) - Membership UN International Resource Panel - Contributions to IPCC, IPBES, UNEP assessments - Advisory roles in EU Soil Mission and national committees **Targets (2026–2031):** - Maintain selective high-level advisory roles - Ensure balanced staff workload between science and advisory engagement - Safeguard academic independence in policy contributions

Table E2: Input of research staff* (reference date 31/12/2025)

	2020		2021		2022		2023		2024		2025	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
1. Scientific staff												
Assistant professor	18	9.6	22	11.2	26	13	26	13.9	26	14	26	13.7
Associate professor**	4	1.7	6	1.9	8	2.7	7	3.7	10	4.8	10	4.9
Full professor**	4	1.6	5	2.1	6	2.3	7	2.9	6	2.9	6	2.9
Postdocs	12	6.3	12	7.5	11	7.2	15	8.7	25	13.4	29	16.2
PhD candidates	30	18.0	38	22.4	52	25.3	61	36.7	72	44.5	77	51.2
Total scientific staff	**68**	**37.2**	**83**	**45.1**	**103**	**50.5**	**116**	**65.9**	**139**	**79.6**	**148**	**88.9**
2. Other staff												
Support staff	2	1.2	2	0.5	4	1.5	6	1.9	9	2.7	15	5.1
Total other staff	**2**	**1.2**	**2**	**0.5**	**4**	**1.5**	**6**	**1.9**	**9**	**2.7**	**15**	**5.1**
Total staff	**70.0**	**38.4**	**85**	**45.6**	**107**	**52**	**122**	**67.8**	**148**	**82.3**	**163**	**94**

* Please note that the association of Dutch universities has, for each specific role, agreed on attributing a certain percentage of the FTE to research, instead of including the full FTE as input of research staff (Definitieafspraken Wetenschappelijk Onderzoek). This also explains any differences with the figures in Table 1 and Figure 2 in paragraph 3.1.

** At Leiden University, full and some associate professors have the 'ius promovendi', meaning that they can be appointed as formal promotors of PhD candidates according to the rules of the Graduate School. CML has 11 professors (employed or otherwise) with ius promovendi and 8 associate professors (employed or otherwise) with ius promovendi.

Table E3.1: Funding

	2020		2021		2022		2023		2024		2025	
	FTE	%	FTE	%	FTE	%	FTE	%	FTE	%	FTE	%
Funding:												
Direct funding	15.4	40.3	21.5	47.3	25.0	48.0	26.2	38.6	28.4	34.5	33.8	36.0
Research grants	5.7	14.8	7.4	16.4	8.4	16.1	10.2	15.0	15.8	19.2	18.4	19.6
Contract research	17.2	44.9	16.5	36.3	18.7	35.9	31.4	46.4	38.1	46.3	41.8	44.5
Total funding	38.3	100.0	45.5	100.0	52.0	100.0	67.8	100.0	82.3	100.0	93.9	100.0

	2020		2021		2022		2023		2024		2025	
	€	%	€	%	€	%	€	%	€	%	€	%
Expenditure:												
Personnel costs	2,063.6	63.4	2,438.0	63.6	2,786.7	57.8	3,579.5	52.2	4,371.7	56.5	4,990.8	59.7
Material costs	1,192.0	36.6	1,397.0	36.4	2,034.8	42.2	3,274.0	47.8	3,364.0	43.5	3,373.6	40.3
Total expenditure	3,255.6	100.0	3,835.0	100.0	4,821.5	100.0	6,853.5	100.0	7,735.7	100.0	8,364.4	100.0

Legend:

Direct funding: 'basisfinanciering'/lump-sum budget.

Research grants: obtained in national scientific competition (e.g. grants from NWO and KNAW).

Contract research: contracts for specific research projects obtained from external organisations, such as governmental organisations, charitable organisations and co-creation with industry.

Table E3.2: Number and types of research grants in the period 2020-2025 (reference date 31/12/2025)

Grant type	2020	2021	2022	2023	2024	2025	Total
Individual grants (NL)				1	2	1	4
Collaborative grants (NL)	2	8	4	10	7	9	40
Individual grants (ERC)		1		1			2
Marie Curie grants (EU)		1			3		4
Collaborative grants (EU)	7	4	7	8	10	3	**39**
Total	9	14	11	20	22	13	89

Legend:

Collaborative grants (NL) consist of NWO/NWA/ZonNW.
Collaborative grants (EU) are mainly Horizon programmes.

Table E4: PhD candidates (reference date 31/12/2025)

Enrolment					Success rate											
					Graduated in year 4 or earlier		Graduated in year 5 or earlier		Graduated in year 6 or earlier		Graduated in year 7 or earlier		Not yet finished		Discontinued	
Starting year		Male	Female	Total	#	%	#	%	#	%	#	%	#	%	#	%
2017*	**All PhDs**	**10**	**16**	**26**	**4**	**15.4**	**7**	**26.9**	**12**	**46.2**	**15**	**57.7**	**4**	**15.4**	**3**	**11.5**
	Employed PhD candidate	7	5	12	0	-	0	-	4	33.3	6	50	2	16.7	1	8.3
	Employees in a PhD track	0	0	0	0	-	0	-	0	-	0	-	0	-	0	-
	PhD candidates- contract	3	10	13	3	23.1	6	46.2	7	53.8	8	61.5	2	15.4	2	15.4
	PhD candidates self-funded	0	1	1	1	100	1	100	1	100	1	100	0	-	0	-
2018	**All PhDs**	**10**	**5**	**15**	**2**	**13.3**	**8**	**53.3**	**9**	**60**	**11**	**73.3**	**3**	**20**	**1**	**6.7**
	Employed PhD candidate	2	1	3	0	-	1	33.3	1	33.3	2	66.7	1	33.3	0	-
	Employees in a PhD track	0	0	0	0	-	0	-	0	-	0	-	0	-	0	-
	PhD candidates- contract	7	2	9	2	22.2	7	77.8	8	88.9	9	100	0	-	0	-
	PhD candidates self-funded	1	2	3	0	-	0	-	0	-	0	-	2	66.7	1	33.3
2019	**All PhDs**	**8**	**6**	**14**	**0**	**-**	**4**	**28.6**	**9**	**64.3**	**9**	**64.3**	**4**	**28.6**	**1**	**7.1**
	Employed PhD candidate	3	1	4	0	-	0	-	2	50	2	50	2	50	0	-
	Employees in a PhD track	0	1	1	0	-	0	0	0	-	0	-	1	100	0	-
	PhD candidates- contract	4	4	8	0	-	3	37.5	6	75	6	75	1	12.5	1	12.5
	PhD candidates self-funded	1	0	1	0	-	1	100	1	100	1	100	0	-	0	-

Enrolment					Success rate											
					Graduated in year 4 or earlier		Graduated in year 5 or earlier		Graduated in year 6 or earlier		Graduated in year 7 or earlier		Not yet finished		Discontinued	
Starting year		Male	Female	Total	#	%	#	%	#	%	#	%	#	%	#	%
2020	All PhDs	10	6	16	1	6.2	5	31.2	7	43.8	-	-	7	43.8	2	12.5
	Employed PhD candidate	5	1	6	0	-	2	33.3	3	50	-	-	2	33.3	1	16.7
	Employees in a PhD track	1	0	1	0	-	0	-	0	-	0	-	1	100	0	-
	PhD candidates- contract	3	3	6	1	16.7	3	50	3	50	-	-	2	33.3	1	16.7
	PhD candidates self-funded	1	2	3	0	-	0	-	1	33.3	0	-	2	66.7	0	-
2021	All PhDs	12	7	19	1	5.3	4	21.1	-	-	-	-	12	63.2	3	15.8
	Employed PhD candidate	5	6	11	0	-	2	18.2	-	-	-	-	6	54.5	3	27.3
	Employees in a PhD track	0	0	0	0	-	0	-	-	-	-	-	0	-	0	-
	PhD candidates- contract	4	1	5	0	-	0	-	-	-	-	-	5	100	0	-
	PhD candidates self-funded	3	0	3	1	33.3	2	66.7	-	-	-	-	1	33.3	0	-
Total		50	40	90	8	8.9	-	-	-	-	-	-	30	33.3	10	11.1

* *Some of the PhD candidates who started in 2017 graduated in more than 7 years. That is why the numbers shown in the 2017 rows don't add up to the total number of starters.*

Appendix B Publications

General performance statistics on publications

Table B1: Descriptive analysis of the scientific peer-reviewed papers from 2020-2025 (till June 2024). (Made by CWTS)

	2020-2021	2021-2022	2022-2023	2023-2024
P[full]	277	301	331	272
AreaGrowth	2.24	2.31	2.36	2.34
PP [OA]	0.9	0.94	0.93	0.89
PP [OA green]	0.86	0.89	0.87	0.69
PP collab	0.92	0.92	0.93	0.91
PP int collab	0.78	0.74	0.71	0.7
PP top10% full	0.22	0.2	0.22	0.27
PP top1%	0.04	0.03	0.03	0.04
MNCS full	1.75	1.62	1.72	1.95
MNJS full	1.45	1.46	1.56	1.76
# cited publications in policy	99	81	82	52
# citing policy docs	449	333	217	102
# citing pol docs	449	333	217	102

Legend:

PP = Proportion of publication output, collab = collaboration, AO = open access,

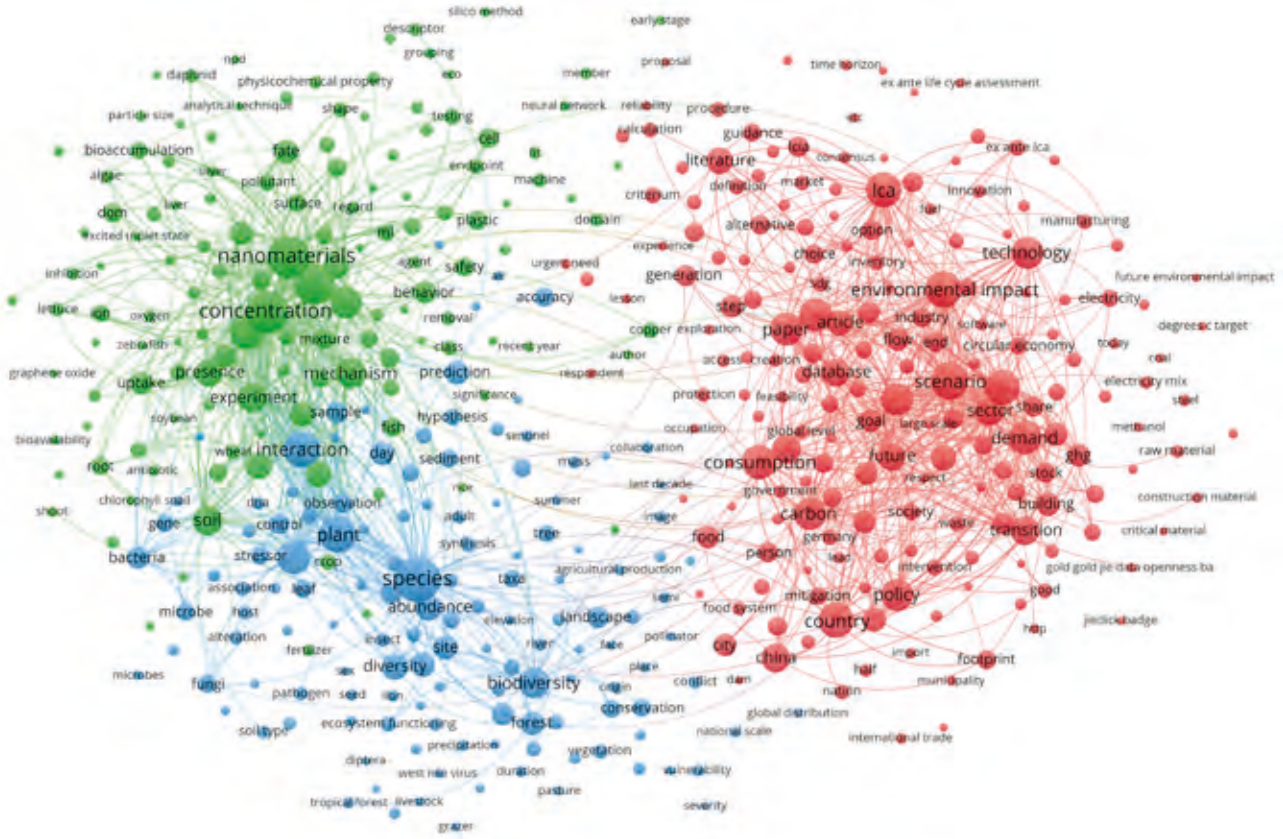
MNCS = mean normalised citation score, MNJS = Mean Normalised Journal Score, # = numbers

The indicators in Table B1 are based on an independent bibliometric analysis by CWTS using Web of Science data (2020– till June 2024), field- and year-normalised and excluding self-citations. During the assessment period, CML produced **1181 scientific publications**, 725 of which were used for the citation analyses. Annual output remained stable, peaking at 331 publications in 2022–2023. Open Access coverage is consistently high (PP[OA] = 0.91), indicating that over 90% of publications are openly accessible.

Collaboration is structurally embedded in CML's research: 92% of publications involve inter-organisational collaboration and 74% involve international co-authorship. Citation impact is well above the global average. The Mean Normalised Citation Score (MNCS) is 1.79, meaning publications are cited 79% above the world benchmark (world average = 1). The share of publications in the top 10% most cited worldwide is 23% (global benchmark: 10%), and 4% are in the top 1%. The Mean Normalised Journal Score (MNJS = 1.57) indicates publication in journals with above-average impact.

Policy relevance is reflected in 192 publications cited in policy documents and 658 policy documents citing CML research.

Figure B2: Keyword co-occurrence network of CML publications (2020–2025), note papers till June 2024 could be incorporated. (Made by CWTS)



This Figure B2 presents a keyword co-occurrence analysis of CML publications from 2020–2024. Keywords were extracted from bibliographic records and mapped based on their frequency and co-occurrence within the same publications.

Node size represents the relative frequency of a keyword, link strength indicates the intensity of co-occurrence, and colours reflect clusters identified through modularity-based community detection.

The network reveals three major, densely connected thematic domains. The first cluster (green) is centred on environmental toxicology and risk assessment, with high-frequency terms such as toxicity, concentration, risk assessment, nanomaterial, fate, and prediction. This domain reflects research on environmental stressors, exposure pathways, and laboratory–field extrapolation.

The second cluster (blue) focuses on biodiversity, ecological processes, and ecosystem functioning, including terms such as plant, soil, diversity, interaction, forest, and habitat. This cluster represents work on species interactions, ecosystem dynamics, soil systems, and multistressor ecology.

The third cluster (red), captures system-level sustainability assessment, impact assessment and techno-economic modelling. Core terms include scenario, emission, environmental impact, policy, consumption, and technology, alongside methodological concepts such as LCA, impact assessment, and Safe-and-Sustainable by Design (SSbD). The network structure illustrates how CML integrates ecological processes (green/blue clusters) with system-level modelling and policy-relevant sustainability analysis (red clusters). Bridging links between clusters demonstrate thematic integration across ecological and techno-economic domains.

Table B3. Authorship structure and academic age of CML publications

Group	Metric	2020	2021	2022	2023	2024
CML PI	# authors	31	36	38	37	40
	Avg. Acad age	23	21	20	20	20
	# pubs	124	103	153	146	97
	Authors per publ	0.25	0.35	0.25	0.25	0.41
CML other	# authors	72	71	93	94	104
	Avg. Acad age	12	10	9	8	7
	# pubs	75	63	87	70	64
	Authors per publ	0.96	1.13	1.07	1.34	1.63
Other	# authors	827	855	893	838	620
	Avg. Acad age	20	18	18	18	16
	# pubs	137	107	149	145	99
	Authors per publ	6.04	7.99	5.99	5.78	6.26

Legend:
Avg Acad age = average academic age, publ = publications, PI = principal investigator

This Table B3 presents publication and authorship characteristics of CML publications between 2020 and June 2024, distinguishing between publications led by CML principal investigators (CML PI), publications co-authored by other CML staff (CML other), and external collaborators (Other).

The data show a steady increase in the number of CML-affiliated authors over time. The number of CML PIs increased from 31 in 2020 to 40 in 2024, while the broader group of CML-affiliated co-authors grew from 72 to 104. In contrast, the number of external collaborating authors fluctuated but remained substantially higher, reflecting the institute's strong collaborative orientation.

The average academic age (years since first publication) of CML PIs declined from 23 years in 2020 to 20 years in 2024. For other CML-affiliated authors, academic age declined more markedly from 12 to 7 years over the same period, confirming the structural integration of early-career researchers into publication output. The average academic age of external collaborators remained stable around 16–20 years. Authorship patterns further illustrate increasing collaboration intensity. The average number of CML co-authors per publication rose from 0.96 in 2020 to 1.63 in 2024, indicating stronger internal co-authorship and integration across research groups. Publications continue to involve substantial external collaboration, with an average of approximately six external authors per publication.

Overall, the data demonstrate three structural developments during the assessment period: (1) growth in CML-affiliated authorship, (2) a clear rejuvenation of the academic staff profile, and (3) increasing internal and external collaboration within publication networks.

Citations within policy documents

CML's research is cited in a substantial number of policy documents produced by governmental authorities, indicating strong uptake of CML knowledge within formal decision-making and regulatory processes (see Figure B4). These citations span global, national, European, and sub-national contexts, demonstrating that CML research informs policy discussions at multiple levels of governance. In addition to governmental bodies, non-governmental organisations (NGOs) constitute a significant source of policy citations. NGO-authored documents draw on CML research to support policy advocacy, environmental protection strategies, and public-interest arguments, particularly in relation to sustainability, environmental quality, and public health. This reflects the use of CML outputs beyond regulatory settings, extending into civil-society-driven policy influence.

Figure B4: CML Citing Policy Organizations

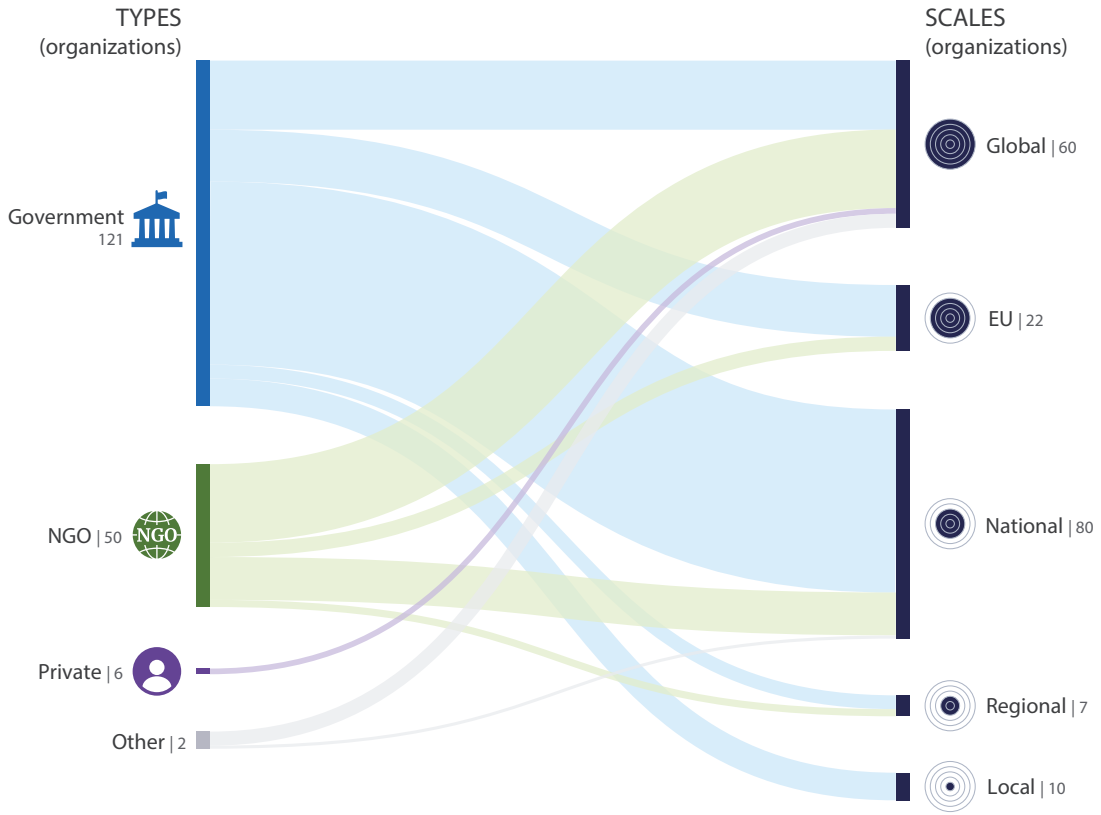


Figure B4 gives insights on which (i) types of organisations and (ii) scales of organisations cite CML work.

A smaller but notable number of policy documents originate from other organisations, including research institutes and private or semi-public actors. These citations indicate the relevance of CML work in applied policy contexts, advisory processes, and knowledge-brokering activities. Across all organisational types, citations occur most frequently in global and national policy documents, highlighting the role of CML research in shaping international assessments, multilateral policy frameworks, and national strategies. Citations at the European level demonstrate alignment with EU-level regulatory and policy development, while local and regional citations, though fewer, indicate targeted uptake in sub-national governance and implementation contexts.

Appendix C Ancillary jobs

Prof. dr. E.G.M. Kleijn	• Lid International Resource Panel • Gemeente Leiden, Lid beoordelingscommissie Subsidie Circulair Verwaarden
Prof. dr. A. Tukker	• TNO, Senior scientist • Nanjing University, Distinguished guest professor • Universitas Padjadjaran, Visiting professorship
Prof. dr. ir. J.B. Guinee	• Adjunct professor at Joint Graduate School of Energy and Environment of King Mongkut's University of Technology
Prof. dr. ing. J.W. Erisman	• Ministerie EZK Voorzitter Wetenschappelijke Klimaatraad (WKR) • Gezondheidsraad Commissie Signalering Milieu en Gezondheid
Prof. dr. ing. M.G. Vijver	• KNAW vaste advieskamer 2de kamer/ Beoordeling impact EU voorstellen op beleid, *https://parlementenwetenschap.nl* • Ministry I&W Advieskamer Bodembescherming • Ministry LVVN Klankbordgroep Uitvoeringsprogramma Gewasbescherming • RISE co-founder, director
Dr. T. Fishman	• TF Sustainability consultancy services
Dr. ir. R. Hoekstra	• MetricsForTheFuture.com • InvestorsForTheFuture.com (discontinued)
Dr. B.R.P. Steubing	• NextLCA: Consultancy and software services
Dr. V. Barbarossa	• Environmental data consulting and technical support: Aquasphere • PBL Netherlands Environmental Assessment Agency
Prof. dr. E. van der Voet	• Member of UN International Resource Panel • Chair of Advisory Committee of United Nations University UNU FLORES

Ancillary activities are professional engagements undertaken at the request of external parties, arising from the position of academic work within society and its inherent connection to societal needs and developments.

NOTE editorial board, members of grant review committees, dissertation committees and proposal reviewers are mentioned generically and not included here.

Appendix D Internal communication channels

There are numerous meeting lines within the organisation.

- Once a week the departments meetings are held; channelling information between staff and MT vice versa; and research field related aspects focused primarily related to instruments and tools. Also opportunities for grants.
- Once every 2 – 4 weeks the research programme meetings are held; here topic related content is discussed. Newest literature, presentations of content or for instance opportunities for grants.
- At the end of each month a newsflash is sent out to everyone for organisation aspects, what has been discussed or is news at MT or Faculty level.
- Approximately every 6 weeks we have an all-in-the-room meeting on dedicated topics that are essential to discuss or explain; e.g. GROW meeting, Finances (a full list is available).
- Once a year there is the CML Science day with internal presentations.
- We have triple E lectures and invited speakers related to events (like some PhD defences or congresses or guest visitors) approx. 10 a year.
- The MT meets every Tuesday; every other week we invite a representative of a group to give 30 minutes update or information. We invite them, but it is also possible to invite yourself. E.g. update on BSc program, PhD support and development, update on LDE, on status Hortus collaborations, advices on grants we do not have (external visitor) and so on.

Appendix E Teaching

Beyond research, CML scientists are deeply committed to teaching and education. We also reach many students and early-career professionals with MOOCs and guest lectures and courses in other curricula across the University of Leiden. We write textbooks: an e-book on environmental toxicology (2019) (eds. Van Gestel ...Vijver) and a textbook on global food challenges (Oxford University Press, eds. Behrens, Bosker and Erhart 2020). We develop, coordinate and offer the:

- MSc Industrial Ecology, in collaboration with Faculty of Technology, Policy & Management (TPM) of Delft University of Technology,
- MSc Governance of Sustainability, in collaboration with Faculty of Governance & Global Affairs,
- BSc Science for Sustainable Societies, in collaboration with Faculty of Social Sciences, and Faculty of Governance & Global Affairs
- Minor Sustainable Development,
- Biodiversity and Sustainability track in MSc Biology,
- Sustainable city track in the BA Urban Studies
- LDE Sustainability Honours Program.

Appendix F Lifelong learning support staff

At CML, we actively invest in the lifelong development of our support staff, fostering a culture of continuous learning and professional growth. This commitment enhances individual careers and the quality of support to research and education within the institute.

Staff are encouraged to grow both within and beyond their roles. For example, one colleague transitioned from office management into educational support as a Study Advisor and Programme Coordinator, while another moved from project support to a position in project management within one of the educational hubs. The research support team has also seen internal mobility, with one member progressing into the role of Director of Operations. These transitions are facilitated through targeted training, mentoring, and access to relevant professional networks.

All support staff regularly engage in professional development. Everyone is trained in LEAN methodologies and has obtained a Green Belt certification. Team development is further supported through annual regular support team days, which include workshops on skills such as curious thinking, giving constructive feedback, and effective communication. These collective learning moments contribute to a strong, collaborative team culture. In line with our ambition to stay ahead of emerging trends, recently, members of the office management, research support, and lab management teams enrolled in a course on the practical application of artificial intelligence in administrative workflows.

We also encourage outward-looking professional engagement. For instance, our grant advisor completed a two-year term as Chair of the European Association of Research Managers and Administrators (EARMA). This leading international network promotes excellence in research support. This position offered valuable leadership experience and strengthened our connections with European peers.

Appendix G Recommendations CML assessment report 2014-2019

Based on page 14 of the Assessment Report Institute of Environmental Sciences (CML) Peer Review 2014–2019 (June 2021), the evaluation committee provided recommendations for the period following 2019. The committee stated that CML can sustain its strong upward trajectory toward excellence across multiple areas—and maintain excellence where it has already been achieved—by giving particular attention to the following recommendations (see table), and how we addressed it (2026).

Advice 2014-2019 evaluation	The way it is addressed (2026)
Consider reforming the present strong research groups into more independent research units, headed by assistant, associate or full professors	CML has been restructured (see section 2). The institute has two departments — Environmental Biology and Industrial Ecology — each led by a Department Head. The Management Board consists of a Scientific Director, Education Director, and Director of Operations, providing institute-wide strategic oversight. Within each department, research groups operate with greater independence and clearer accountability, headed by assistant or associate professors. Five cross-cutting research programmes — Water, Urban, Future Food, Resources & Energy, and Biodiversity — span both departments, with varying levels of involvement reflecting each department's strengths.
Establish a dedicated position to coordinate CML's science-policy activities and to plan those further, building on the excellent outreach work already being done by CML researchers	Rather than creating a single coordination role, CML has developed a distributed model in which multiple senior scientists actively lead science-policy engagement in their respective domains. These researchers serve as role models and provide guidance to early-career staff navigating the science-policy interface. This approach is embedded in CML's strategy and reflected in the profiles of staff listed in Appendix C.
Request Leiden University to offer more researchers a permanent contract and provides them with opportunities to do independent research	The changes to the Dutch Collective Labour Agreement (CAO, 2021–2022) created a structural basis for offering more permanent contracts, and CML has actively pursued this within its staffing strategy. The proportion of staff on permanent contracts has increased over the evaluation period, supporting greater stability and enabling more independent research trajectories.

Advice 2014-2019 evaluation	The way it is addressed (2026)
Develop a more structured policy for helping junior staff with their careers inside and outside CML and with further developing academic leadership and outreach skills	CML has significantly strengthened its support for early-career researchers. Concrete measures include the Vlootschouw talent review process, structured GROW conversations, a mentor and buddy system during onboarding, and access to Faculty-wide leadership development courses. These are described in full in section 3.
The committee advises CML to further explore, identify and communicate specific research themes where the institute is—or is able to become— world-leading.	These are elaborated in sections 4 and 5, and form the core of CML's forward strategy in section 7.
Faculty of Sciences' Graduate School to explore with CML the demand for specific courses for PhD candidates targeted at their specific needs.	PhD candidates at CML have access to approximately 100 courses offered at Leiden University level, and are encouraged and supported to obtain study credits through tailored training outside the university where this better fits their development needs. CML actively monitors PhD training plans to ensure alignment with individual research trajectories.
Advises the Faculty of Sciences to install an independent, confidential advisor for consultation in the case of integrity issues.	A dedicated PhD confidential adviser has been appointed at Faculty level. She conducts an annual meet-and-greet with each incoming PhD cohort at CML, and her role and contact details are communicated during PhD training and supervision meetings.
Continue to work towards a more balanced gender position of CML's staff.	Gender balance has not yet been fully achieved, as described in section 3.1. CML actively monitors gender distribution across career levels and has taken steps to embed diversity and inclusion considerations in recruitment, promotion, and leadership development processes. CML expects a more equal distribution at each professional level to be achieved within the next three years, and remains committed to reporting progress transparently.
More staff with lower teaching time	CML has diversified its staff profile as the institute has grown, increasing the proportion of postdoctoral researchers, technicians, dedicated teaching staff, and support staff. This diversification has created more flexible workload distribution across the institute. CML maintains the principle that all academic staff contribute to teaching in line with the standard Dutch 40:40:20 model (research, teaching, and organisational duties), while recognising that different contract types allow for variation in the balance of these contributions. See Appendix A for full details.