

## **Scientific Audit**

# **RIVM Centre for Environmental Quality (Centrum Milieukwaliteit-MIL)**

Report of the external audit committee

February 2024

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## List of Abbreviations

<b>AC</b>	Audit Committee
<b>CBS</b>	<i>Centraal Bureau voor Statistiek</i> (Statistics Netherlands)
<b>EMEP</b>	European Monitoring and Evaluation Programme of long-range transmission of air pollutants
<b>EOSC</b>	European Open Science Cloud
<b>EU</b>	European Union
<b>FAIR</b>	Findable, Accessible, Interoperable, Reusable
<b>FTO</b>	<i>Faciliteiten Toegepast Onderzoek</i> (Facilities for Applied Research)
<b>GGD</b>	<i>Gemeentelijke of Gemeenschappelijke Gezondheidsdienst</i> (Municipal Public Health Service)
<b>GWI</b>	<i>Grootschalige Wetenschappelijke Infrastructuur</i> (Large-scale Research Infrastructure)
<b>IIR</b>	Informative Inventory Report
<b>INSPIRE</b>	Infrastructure for Spatial Information in Europe
<b>IT</b>	Information technology
<b>KNAW</b>	<i>Koninklijke Nederlandse Akademie van Wetenschappen</i> (Royal Netherlands Academy of Arts and Sciences)
<b>LGW</b>	<i>Landbouw en Grondwater</i> (Agriculture and Groundwater Department)
<b>LKG</b>	<i>Luchtkwaliteit en geluid</i> (Air Quality and Noise Department)
<b>LML</b>	<i>Landelijk Meetnet Luchtkwaliteit</i> (Dutch air quality monitoring network)
<b>LMM</b>	<i>Landelijk Meetnet effecten Mestbeleid</i> ( Dutch Minerals Policy Monitoring Programme)
<b>LNV</b>	<i>Ministerie van Landbouw, Natuur &amp; Voedselkwaliteit</i> (Ministry of Agriculture)
<b>CLRTAP</b>	Convention on Long Range Transboundary Air Pollution
<b>MIL</b>	<i>Centrum voor Milieukwaliteit</i> (Centre for Environmental Quality)
<b>MMK</b>	<i>Metingen Milieukwaliteit</i> (Measurements Department)
<b>VWS</b>	<i>Ministerie van Volksgezondheid, Welvaart en Sport</i> (Ministry of Health, Welfare, and Sport)
<b>MT</b>	Management Team
<b>NECD</b>	EU Directive on National Emission reduction Commitments
<b>NGO</b>	Non-Governmental Organization
<b>NKS</b>	<i>Nationaal Kennisprogramma Stikstof</i> (National Nitrogen Research Programme)
<b>NWO</b>	<i>Nederlandse Organisatie voor Wetenschappelijk Onderzoek</i> (Dutch Research Council)
<b>OIM</b>	<i>Afdeling Onderzoek en Innovatie Milieukwaliteit</i> (Environmental quality research and Innovation Department)
<b>PBL</b>	<i>Planbureau voor de Leefomgeving</i> (Netherlands Environmental Assessment Agency)
<b>RIVM</b>	<i>Rijksinstituut voor Volksgezondheid en Milieu</i> (Dutch National Institute for Public Health and the Environment )
<b>RvA</b>	<i>Raad voor Accreditatie</i> (National Accreditation Board)
<b>SAB</b>	Scientific Advisory Board (SAB, <i>Cvt- Commissie van Toezicht</i> )
<b>SEP</b>	Strategy Evaluation Protocol
<b>SMO</b>	<i>Stoffen monitoring en Onderzoek stikstof</i> (Substances Monitoring and Nitrogen Research Department)
<b>SPA</b>	<i>Stikstof Programma Aerius en Advies</i> (Nitrogen Policy Support Department)
<b>SWOT -analysis</b>	Analysis of strengths, weaknesses, opportunities and threats

<b>TNO</b>	<i>Nederlandse organisatie voor toegepast-natuurwetenschappelijk onderzoek</i> (Dutch Organization for Applied Scientific Research)
<b>ToR</b>	Terms of reference
<b>UNECE</b>	United Nations Economic Commission for Europe
<b>WHO</b>	World Health Organization

## 1 Summary

This report presents the evaluation of the research quality, the societal relevance and the viability of the Centre for Environmental Quality (*Centrum voor Milieukwaliteit-MIL*) of the Dutch National Institute for Public Health and the Environment (RIVM). This audit was commissioned by the Scientific Advisory Board (SAB, *Commissie van Toezicht-CvT*) of RIVM and was performed by an external audit committee. It forms part of a regular cycle of audits performed for the SAB, which supervises the scientific quality and independence of the RIVM. The committee based its conclusions on a self-evaluation report with additional documentation compiled by MIL; a stakeholder consultation report written by an independent consultant; and a series of dialogues with MIL experts and members of the MIL Management team during a two-day site visit in December 2023.

According to the Terms of Reference (ToR) the main function of this audit was to assess: 1) whether MIL monitors what is needed for environmental policy making; 2) whether MIL methods are fit for purpose; and 3) whether MIL is sufficiently prepared for emerging issues and developments. The purpose of the audit also was to come to forward looking recommendations to reduce the vulnerability of MIL output and to improve insights in the relation between trust in MIL's output and methods on the one hand and the inherent uncertainty in environmental knowledge on the other. To this end, the audit committee focussed on the following criteria mentioned in the Standard Evaluation Protocol (SEP) and RIVM Guide for Evaluation: *Research Quality (Fit for Purpose)*; *Relevance for Society*; *Viability & Future Proofing*; and *Open Science*.

### *Research Quality (Fit for Purpose)*

- Within MIL there is a high awareness of the importance of research quality as well as operational and technical quality. Measuring and monitoring take place according to fit for purpose standards.
- With a few highly valued exceptions, visibility of MIL experts and MIL work in academic journals and networks is limited. The AC feels that the research quality (scientific credibility) could be enhanced by increased emphasis on publications in international scientific journals. Increased visibility in the academic world would also increase visibility in professional networks and enhance MIL's chances to acquire extra funding, such as in the competition of EU programmes or the internal RIVM Strategic Research Programme.
- The external scientific review of MIL reports is currently limited; finding ways to combine commissioned reporting with scientific publishing, and contributing to consortium publications could be a way to invest precious time efficiently and to enhance the support base.
- The MIL management has a clear ambition to build a stronger, policy-relevant knowledge base, amongst others by cooperation with universities and other institutions (national and international). However, the extent to which this ambition materialises for the staff in general, currently depends on the initiative of individual researchers and ad hoc commissioned work. In general MIL could be acting more pro-active in convincing the ministries that also methodology development should be commissioned. This would increase both MIL's policy relevance and independence.
- For specific cases MIL is not sufficiently explicit and clear on the limits within which models, fed by input data, can still be used. Boundaries in spatial and temporal resolution and lowest boundaries with regard to depositions or concentrations should be more actively communicated. MIL should take responsibility to avoid the mis-use of models and data outside of these boundaries.

### *Relevance for Society*

- It is evident that the work of MIL has a high societal relevance. Overall, the stakeholder consultation shows that commissioners at the national level (ministries) are overall quite positive about the work of MIL and its timeliness. Also, at other governmental levels (provinces, municipalities) and among other stakeholders, MIL information is seen as very relevant, though critical remarks were made about the way results and uncertainty in model outcomes are communicated and about openness towards other approaches.
- There is a threat that MIL's high commitment and motivation to contribute, leads to overburdening of staff. Policy makers, other stakeholders and citizens asking questions are not always aware of the complexity of their questions and the required time and budget to provide answers. While MIL could be more explicit about these constraints, policy makers could take responsibility here too. In the case of individual questions from citizens, targeted information via the website and other media might relieve the burden.
- The AC finds the results from the projects with citizen scientists impressive and promising. These initially started within OIM and then expanded to other projects within MIL. Further systematic expansion and learning from these experiences could offer an important opportunity to further increase trust and societal relevance of the work of MIL. A next step could be taken by incorporating data collected through citizen scientists in the basic data streams, and by investing in extra support for citizen science networks and their techniques

### *Viability & Future Proofing*

- The AC welcomes the recently developed model strategy which was presented for air quality. The AC would also welcome a data strategy, as well as a vision on measurement infrastructure, which currently are both lacking.
- The AC supports the explicit wish of management and staff to work on further methodological development and innovation. The AC is also positive on the roads explored towards using Artificial Intelligence and Machine Learning. As methodological development is in the public interest and urgently needed to keep regular work at high and up-to-date operational standards, methodological developments should be part of what is commissioned. This can be done by extending the budget, but in view of limitations in resources also choices are to be made by MIL itself in conference with the responsible ministries. Currently, the room to invest in methodological development and innovation seems too limited, which affects the viability.
- This also seems to hold for key fields of expertise which are only represented by a single employee. Some more redundancy would be applauded. Again, this calls for a clear vision and strategy of MIL which new roads to take and, consequently, which to abandon.
- Young employees do like to work at MIL, and are well supported by more experienced colleagues. Their collective voice, also with regard to inspiration for future developments and innovation, could be more systematically organised.

### *Open Science*

- The AC is positive about the current FAIRness of MIL models and applauds the ambition to take next steps regarding open data and to catch up with the EU Infrastructure for Spatial Information in Europe (INSPIRE) and the European Open Science Cloud (EOSC).
- The AC welcomes the ambition and efforts of MIL to be more transparent and to communicate about uncertainties. At the same time MIL could be

more aware that different audiences need different ways of communicating uncertainties, and that in contested policy settings more technical details and transparency do not automatically lead to more public trust.

### *Strategic Recommendations*

1. Dare to make choices and, as a consequence, sometimes say no. Hold on to your strengths and specific niche in environmental expertise for public policy-making: measuring & modelling (including development of methods), interpretation, signalling, reporting and policy advising. Avoid to get involved in executive tasks as related to policy implementation, permitting and compliance.
2. Invest time and resources in international academic journal publications, accompanied by targeted summaries in Dutch, accessible through relevant media. Invest in clear and concise communication and differentiated ways of communicating uncertainties.
3. Develop a vision with regard to MIL's position and role in the Dutch and international "landscape of expertise" and the necessary research infrastructure – both in-house and distributed –, including the scope of application of current MIL methods, tools and methodological perspectives for specific policy uses. In order to do so, make sure that relevant expertise on policy science is onboard.
  - Use this vision to decide which tasks to embark on and which to avoid or abandon: different policy and legal settings ask for different evidence standards. Be clear and consistent about which methods are "fit" for which "purpose". E.g. refrain from using the AERIUS-tool for permitting.
  - Use this vision to decide on the course of methodology development and innovation, on investment of time and resources in international research networks, joining European research projects and global programmes. This will also support the discussion with commissioners for the needed resources (including possibilities for co-funding). Be explicit on the MIL research agenda and needs when interacting with commissioners.
  - Use this vision to intensify cooperation with Dutch Universities and with other relevant research institutions. Ensure in this cooperation to collaborate as equal partner respecting the role and position of the other partners. Use the current momentum of shared research projects and infrastructure programmes to further enhance cooperation.
  - The vision on MIL's specific niche will support the division of labour with collaborating partners. In some cases, a partner in the network might be able to pick up certain questions, in other cases the academic network as a whole could show that some questions cannot be answered by more scientific detail and need other forms of deliberation.
4. Keep investing time and resources to participate and be visible in EU policy support, international scientific bodies and science-policy boundary organisations. Make sure that retiring MIL experts are replaced timely and knowledge and contacts are transferred to colleagues.

## 2 Introduction

This report presents the evaluation of the Centre for Environmental Quality (*Centrum voor Milieukwaliteit-MIL*) of the Dutch National Institute for Public Health and the Environment (RIVM). The evaluation (audit) was commissioned by the Scientific Advisory Board (SAB, *Commissie van Toezicht - CvT*) of RIVM whose task it is to supervise the scientific quality and independence of RIVM's work. The last audit of MIL dates from 2005. Regular audits fulfil a duty of accountability towards government and society. As such, this audit is part of a series of evaluations of various research fields and RIVM-centres, and was performed by an external audit committee (AC, described in section 2.4) using the *RIVM Guide for external evaluations* (section 2.3).

### 2.1 Centre for Environmental Quality at RIVM

RIVM operates at the interface of science, policy, and society. In general, the work of RIVM focuses on research, policy support, information provision, monitoring and surveillance, crisis and incident management. RIVM is governed by specific Dutch legislation ('Act on the RIVM'), in which its key tasks and independent position are laid down and ensured. Based on the scientific evidence or advice of RIVM, policy actors are enabled to make evidence-based or evidence-informed policy. To fulfil its role as a trusted advisor to 'society at large', information provision to citizens, non-governmental organisations (NGOs), (inter)national stakeholders, media, professionals etc. is a crucial part of RIVM's role.

The main tasks of the Centre for Environmental Quality (MIL) are monitoring and assessing emissions of pollutants to air and water; monitoring and assessing the chemical and physical quality of air, soil, surface water and groundwater; as well as monitoring and assessing deposition of pollutants on amongst others nature areas. MIL is responsible for up-to-date and reliable data in support of national policy evaluation and the development of policies.

MIL is organised in 6 departments employing 174 persons (not counting contractors): Measurements (Metingen Milieukwaliteit (MMK) – 43P); Emissions and nitrogen research (Stoffen, Monitoring en Onderzoek stikstof (SMO) – 35P); Nitrogen policy support (Stikstof Programma Aerijs en Advies (SPA) – 14P); Environmental quality research and innovation (Onderzoek en Innovatie Milieukwaliteit (OIM) – 19P); Agriculture and groundwater (Landbouw en Grondwater (LGW) – 18P); and Air quality and noise (Luchtkwaliteit en geluid (LKG) – 29P).

The regular monitoring work is primarily funded by ministries, especially the ministries of Infrastructure and Water Management; of Agriculture, Nature and Food quality (including Nitrogen policy); of Economic Affairs and Climate; and of Internal Affairs. The work programme of MIL is defined annually on the basis of policy questions and international and EU reporting obligations. There is an increased interest from provinces and cities for local measurements. Also, the public involvement in monitoring work is increasing. MIL furthermore participates in strategic innovative research of RIVM and in international research programmes.

#### *Recent Developments*

MIL experiences a constantly growing number of requests for data and policy support. In the period 2018-2023, the number of employees has increased by 30-40% in order to keep up with these requests. A pressing question for MIL is what can be delivered with the available staff and research tools, and what cannot be taken on board.

Increasingly, MIL is requested to add to its monitoring- and policy evaluation-task the support of policy development itself. MIL also tends to get more involved in



policy implementation, permitting and compliance. The strategic question is: Whether and how monitoring tasks can be combined with specific policy tasks, such as licensing, policy design, and local/regional policy issues.

## 2.2 Scope and Function of the Audit

The main function of the audit described in this report was to assess: 1) whether MIL – concerning physical and chemical environmental quality – monitors what is needed for environmental policy making; 2) whether MIL methods are fit for purpose; and 3) whether MIL is sufficiently prepared for emerging issues and developments. The audit also has a forward look with recommendations to improve the acceptance of results and reduce the vulnerability of MIL output.

MIL provides input to several sensitive policy areas (which cover around 80% of all MIL research capacity) for which scrutiny of data and robust interpretation of modelling results are crucial. The audit focused on the following MIL monitoring activities:

- Emission registration and monitoring of pollutants to air and water
- Exceedances of EU-air quality limit values and WHO-guideline values for air quality
- Excess nitrogen deposition on EU Natura2000 areas
- Nitrate leaching to groundwater (EU Nitrate Directive and derogation, EU Water Framework Directive)

MIL activities on noise, substances of very high concern (SVHCs), and agricultural pesticides were excluded from the evaluation.

Four main questions posed by MIL summarise the scope of the audit:

1. *Relevance and readiness for the future:* Is MIL sufficiently able to effectively and timely support policy processes? What should be strengthened in order to be ready for increasingly complex issues?
2. *Interaction with policy and society:* Is policy advice of MIL independent and robust given scientific uncertainties? Is our interaction with policy and society in balance, given the trend towards multilevel governance?
3. *Research quality, quality assurance & scope of application:* Where could scientific quality and quality control be improved? How can we better communicate about sound application ranges of models and data sets (given increasing demand for spatial detail and use in juridical settings)?
4. *Transparency:* Are models and data sufficiently publicly available (FAIR: Findable, Accessible, Interoperable, Reusable) and how can correct application be ensured? Are we sufficiently transparent about methods and uncertainties?

## 2.3 Followed Procedures

The executive board of RIVM appointed an internal *audit project team* led by Rob Maas and Rona Helder. This project team drafted the 'Terms of reference' and organised the evaluation process and programme under responsibility of and in close cooperation with the SAB, with moments of feedback from the chair and the scientific secretary to the AC. Two members of the SAB (Professor Carolien Kroeze and Professor Frans Russel) were appointed as liaison officers.

The evaluation procedure followed the *RIVM Guide for external evaluations*, which in itself is based on the *Strategy evaluation protocol 2021-2027 (SEP)*, drawn up by the Universities of the Netherlands, Royal Netherlands Academy of Arts and Sciences (KNAW), and the Dutch Research Council (NWO). The primary aim of SEP assessments is to evaluate the research quality, societal relevance, and viability of a research unit considering its own aims and strategy, and to suggest

improvements where necessary. The SEP is geared towards the evaluation of research conducted at Dutch universities, University Medical Centres, NWO- and KNAW institutes. The RIVM Guide accommodates the evaluation of the broader tasks of RIVM, i.e., its role as a trusted advisor for government and society in view of its role as a research institute.

#### *Stakeholder Consultation*

An important input to the audit was a Stakeholder Consultation, which focused on the interaction between MIL and its customers, data providers, policy makers and interest groups. In August 2023 the MIL project team identified a gross list of relevant stakeholders which was shared with the AC for consultation. Based on the input of the AC, the project team derived a final list. During September and October 2023, independent consultant Dr Susan van 't Klooster (SAVIA) conducted 19 interviews with external stakeholders and in addition the project team conducted five interviews with internal RIVM users of MIL information. Key questions were whether MIL was timely and effectively delivering reliable information to policy makers, stakeholders and other research projects; whether MIL results and methods were sufficiently transparent, and whether its policy advice was appreciated and useful.

#### *Documents*

At the end of October 2023, the AC received the following documents from the project team:

1. Description of MIL activities
2. Self-evaluation, including: a SWOT (strengths, weaknesses, opportunities, threats) analysis by the management team of MIL; an overview of recommendations from earlier evaluations and follow up actions; self-evaluations by the project team on:
  - Emissions
  - Modelling air quality and deposition
  - Air quality measurement
  - Water monitoring networks
3. Stakeholder consultation report, which included reports of 15 structured interviews with external stakeholders, conducted by an independent consultant (Dr Susan van 't Klooster, SAVIA) as well as of five interviews with internal RIVM users of MIL information, conducted by the project team;
4. Draft site visit programme

In the first week of December 2023, the AC received in addition:

1. Adapted draft site visit programme
2. Draft report on uncertainties in Nitrogen Deposition
3. Draft reaction on Report of De Nieuwe Denktank "Uit de stikstofcrisis – verantwoord omgaan met onzekerheid"
4. Draft final report evaluation Emission registration ("top 100 process") by Andersson Elffers Felix)
5. Discussion note on application range Emission Registration
6. Draft hand out for site visit 21-22 December
7. Draft overview of CVs project team & AC
8. Reports of four additional Interviews with Stakeholders

Furthermore, the AC took the following separate scientific evaluations into consideration:

- Scientific evaluation of the LMM programme (groundwater monitoring) (2023)
- Advisory committee 'measurement and calculation of nitrogen' (commission Hordijk) - 2020

- Review on the scientific underpinning of calculation of ammonia emissions and deposition in the Netherlands (Professor Mark Sutton) - 2015
- Monitoringsysteem luchtkwaliteit in perspectief (van Alphen en Pot) - 2015
- Final report on the evaluation of the LMM (Dutch Minerals Monitoring Programme) - 2011
- Scientific Audit on Monitoring and Modelling Environmental Quality – 2008

#### *Pre-evaluation and site visit*

To share first impressions, as well as questions to be asked during the site visit, separate individual online exchanges with the chair and secretary and AC members were organised. The input of the AC members was used for preparing the site visit. This also resulted in a request for additional information from MIL on external (European) research funding, in order to better assess possibilities for scientific development, cooperation and innovation.

The site visit took place on Thursday 21 and Friday 22 December 2023, preceded by an informal dinner on Wednesday evening. The site visit started with a session with SAB liaisons Carolien Kroeze and Frans Russel who briefed the audit committee on the purpose, focus and procedures of the audit and who asked for special attention to the relationship between uncertainty and trust. During these two days, the AC conducted a series of dialogues in a physical face-to-face setting with groups of MIL experts and MT members. On the second day an extra session was arranged with young and recently recruited employees in order to discuss their views on the organisation, their own development opportunities, the work conditions and the challenges involved. The feedback session on the last day took place in the online presence of SAB liaisons Carolien Kroeze and Frans Russel.

#### *Drafting the Report and Fact Check*

The AC weighed all information that was provided to the committee, including the self-evaluation report, the stakeholder consultation report, additional information provided during the site visit and the dialogue sessions, and based its conclusions on the combination of these sources. This audit report was drafted by the AC scientific secretary in close consultation with the committee and the AC chair. At the beginning of February, the AC scientific secretary sent the final draft report to RIVM for a check on factual points, after which the committee finalised the report as submitted to RIVM on 7 February 2024.

## **2.4 Members of the Audit Committee**

The SAB of RIVM appointed as members of the AC:

- Professor Arthur Petersen – *chair* (Professor of Science, Technology & Public Policy University College London);
- Dr Birgit Loos (Managing Director of Wageningen Food Safety Research);
- Dr Willem Halffman (Institute for Science and Society, Radboud University Nijmegen);
- Professor Bert Holtslag (Professor Emeritus of Meteorology at Wageningen University);
- Professor Annemarie van Wezel (Professor of Environmental Ecology, University of Amsterdam).

Independent scientific secretary to the AC:

- Dr Willemijn Tuinstra (Tuinstra Kennisadvies)  
Stakeholder interviews:
- Dr Susan van 't Klooster (SAVIA)

## 3 Findings

### 3.1 Research Quality (Fit for Purpose)

The AC evaluated the research quality of MIL with regard to its role of monitoring and surveillance. Therefore, the most important aspect of research quality considered here is to what extent the research contributes to the execution of this operational role. This means that the committee evaluated whether the research is 'fit for purpose'.

It should be noted that although the main purpose of MIL's work is to monitor environmental quality trends, MIL also takes up the task of giving policy advice: suggesting possible policy measures, strategic choices, including assessments of their likely outcomes. In addition, outcomes of MIL models are now used more directly in policy making and more recently also in permitting.

Overall, the AC found MIL's measuring and monitoring methods 'fit for purpose', based on state-of-the-art knowledge, a finding which is congruent with earlier findings of scientific reviews by e.g. the advisory committee on measurements and modelling (Cie Hordijk 2020) and process evaluations like the evaluation of the quality assurance process of the Emission Registration by AnderssonElffersFelix (2023).

With regard to the role of direct policy advice the AC noted that MIL departments and programmes vary in the extent to which they take up this task and in the way they decide to do so. In cases where methods for policy advice have turned out not to be fit for purpose, the methods used were originally meant for other purposes or different scales. For example, the Aerius model is fit-for-purpose to analyse trends on a national and regional scale, but the application of an adapted version on a lower scale did run into problems.

#### *Scientific Integrity & Independence*

The AC has sensed at MIL a high level of commitment and motivation to deliver impartial and reliable policy-relevant information. The AC is convinced of the scientific integrity of MIL employees and senses a high responsibility for the quality of the results.

Independence of MIL research is formally arranged within the Act on the RIVM. According to this act, the government and ministries can commission research on specific topics, but they cannot determine how the research is carried out or how the outcomes are reported. RIVM has installed a system to ensure scientific integrity and independence, including codes of conduct for its personnel, guidelines on public-private partnerships, trainings for staff, the appointment of an independent confidant for scientific integrity, peer review audit procedures such as this one, and the supervision by the SAB.

At the same time, and given the high commitment to deliver, MIL experiences a delicate balance between maintaining an independent position and delivering policy-relevant results. Because time is either needed for commissioned work following routines, or is devoted to additional questions demanding quick reactions, generally not much room is felt for an own research agenda on methodology development or reflection on methodology. MIL could be more proactive in discussions with ministries and research organisations to acquire more room, as this is in the interest of both the quality of the routine work and of the answers to additional requests (including the assessment of their feasibility). Recently, for specific cases, the AC is of the opinion that MIL has not acted sufficiently independent and has not been sufficiently clear about the limits within which models, fed by input data, can still be used for the purpose intended by policy makers. Boundaries in spatial and temporal resolution and lowest boundaries with

regard to depositions or concentrations should be more actively communicated. MIL experts are aware of the fact that uncertainties increase when results are presented at a finer spatial (or temporal) scale, or when the contribution of specific emission sources (or even individual emitters) is requested. Therefore, the AC recommends that MIL takes more responsibility to avoid the use of models and data outside of these boundaries.

#### *Quality Assurance & Quality Control*

MIL's monitoring networks have extensive quality assurance and quality control mechanisms in place. Some are accredited, like the air quality monitoring network (LML) (ISO 17025) which is frequently audited by the national Accreditation Board (RvA). Also for the Informative Inventory Report (IIR), Emission Registration is regularly subject of in-depth technical reviews by international review teams, both under the EU Directive on National Emission reduction Commitments (NECD) and United Nations Economic Commission for Europe Convention on Long Range Transboundary Air Pollution (UNECE-CLRTAP).

Still, mistakes do happen, and in the self-evaluation MIL expressed the question to what extent RIVM is only accountable for its "own" part of the work, or for the work of the whole consortium. Mistakes of others can harm the trustworthiness of RIVM. The AC is of the opinion that this risk can be diminished when various partners in the consortium participate on an equal footing and when the consortium presents itself to the outside world accordingly.

#### *External Review & Academic Visibility*

While in part there are extensive procedures in place to review MIL's data, external review of MIL reports is currently limited. Some of the individual programmes have external review procedures in place especially when reports are written within the context of a consortium, but often reports are only reviewed internally. For an international audience, reports that are in Dutch are difficult to review or access even after they have been published. Finding ways to combine commissioned reporting with scientific publishing, and contributing to consortium publications could be a way to invest precious time efficiently and enhance the support base.

With a few highly valued exceptions, visibility of MIL experts and MIL work in academic journals and networks is relatively limited. Partly this is due to time constraints, and partly this has to do with the nature of MIL's tasks. The AC feels that the research quality (scientific credibility) could be enhanced by increased emphasis on publications in international scientific journals. Increased visibility in the academic world would also increase visibility in professional networks and enhance MIL's chances to acquire extra funding for methodology development, such as in the competition for national and EU research programmes or the internal RIVM Strategic Research Programme.

#### *Scientific Cooperation*

The MIL management has a clear ambition to build a stronger, policy-relevant knowledge base, amongst others by cooperation with universities and other national and international institutions. This commitment is put into practice by two out of the over 170 MIL experts combining their work with professorships and special chairs at universities (2 professorships, (0,6 fte) and other arrangements). The extent to which this ambition materialises for the staff in general, currently depends on the initiative of individual researchers.

### **3.2 Relevance for Society**

Evidently, the work of MIL has a high societal relevance. MIL data and modelling results are widely used and are crucial in the support of policy development. Overall, the stakeholder consultation shows that commissioners at the national

level (ministries) are rather positive about the work of MIL and its timeliness. Also at other governmental levels (provinces, municipalities) and among other stakeholders, MIL information is seen as very relevant, though here and there critical remarks were made about communication and openness towards other approaches. According to interviewees MIL could provide more clarity in advance about what can and cannot be asked and also provide clarity about what the data mean (interpretation). In case of critique solutions could be sought more in connection with users and also with other research groups.

The AC finds the results from the projects with citizen scientists impressive and promising. These projects started within OIM and expanded to other projects within MIL. Further systematic expansion and learning from these experiences could offer an important opportunity to further increase trust and societal relevance of MIL's work. A next step could be taken by incorporating data collected through citizen scientists in the basic data streams or in investing in extra support for citizen science networks and their techniques.

### **3.3 Viability & Future Proofing**

#### *Vision Development & Innovation*

The AC supports the explicit wish of management and staff to work on further methodological development and innovation. Currently, the room to invest in method development and innovation seems too limited and this affects future viability. Methodological development is in the public interest and needed to keep regular work on a high standard. Hence, the AC is of the opinion that also methodological development should be part of what is commissioned. This can be done by extending the budget, but in view of limitations in resources also choices have to be made by MIL in conference with the responsible ministries.

Overall, MIL could be more proactive in developing its own research agenda. Within several programmes in MIL, this is already happening. For example, in the water monitoring networks new questions regarding drought and leaching are addressed, and an integral approach of water quality, nature preservation and climate change is explored in interaction with other research institutes. The AC also applauds the gradual shift from the national OPS model to EMEP and ensemble modelling; the roads explored towards comparing with satellite data; and the use of Artificial Intelligence and Machine Learning. The AC welcomes the recently developed model strategy presented for air quality and its embedding with EMEP. The AC would also welcome a data strategy as well as a vision on the measurement infrastructure. However, giving limited resources, well-reasoned choices will need to be made on which developments should be prioritised and which scaled down.

#### *Human Resources*

In the last few years the number of employees at MIL has increased substantially. This has led to an influx of a high number of younger employees. The AC has spoken to a group of them to get an impression of the onboarding of these new employees and their perceived career perspectives. Young employees like to work at MIL, and are well supported by more experienced colleagues. At the same time, career perspectives were not always clear and the impression was that personal ambition and initiative were the most determining factors to move forward. MIL-MT could invest more coherently in the development of (young) employees to stay an attractive employer in a difficult labour market and also to retain experience in the future. Also the collective voice of the younger employees, e.g. with regard to inspiration for future developments and innovation, could be more systematically organised.

Some key fields of expertise are vulnerable because they are only represented by a single employee. Some more redundancy would be applauded, also because some

of the highly experienced staff who are key nodes in national and international policy and science networks are retiring. Again, this calls for a clear vision and strategy of MIL on which new roads to take and, consequently, which to abandon. In this regard, more use could be made of experiences of other knowledge institutes operating at the interface between science and policy. These experiences are documented in the policy science literature, but academic expertise in policy science is not very prominent within MIL at present.

MIL employees are under relatively high societal pressure, especially those working on the politically sensitive fields. It is important that researchers feel safe to do their work, and know that they are backed up by the management also when their work is challenged. The AC got the impression that young employees felt safe and supported by more senior colleagues and had the room to grow accustomed to the pressure and challenges of policy settings. Still, policies with regard to the safeguarding and further empowerment of the employees can be more detailed and explicit reference could be made to e.g.

<https://www.wetenschapveilig.nl/wetenschappers>

### **3.4 Open Science**

*FAIR (Findable, Accessible, Interoperable, Reusable)*

In recent years substantial efforts have been undertaken to make documentation of basic assumptions in MIL models and data publicly available. Overall MIL's models and documentation can be found on the internet and in the grey literature (for example, the description of OPS by Sauter et al. in 2018). Also, some recent contributions are made to the international reviewed literature (like the evaluation of OPS with observations in comparison with LOTOS-EUROS and EMEP4NL on larger scales, van der Swaluw et al., 2017, 2021). However, general information on the applicability of models is lacking or difficult to read.

*Open Data*

Currently data management at MIL is organised at project level and some catching up has to be done regarding metadating and making information about the quality of the data available. The AC noted and encourages the fact that MIL is working on a data strategy exploring how generalizing data management would make it easier to exchange data between projects according to the FAIR principles. This would indeed be important in order to ensure that information about quality and reproducibility is not lost in the often complex data streams. The AC welcomes the plans to catch up with EU INSPIRE and EOSC and applauds the involvement of RIVM in the recently started LTER-LIFE consortium. This could act as a trigger to connect to other open data sets, which would enable a combined and wider use of data.

*Liability*

In addition to what is arranged in general rules and regulations of RIVM, the AC recommends MIL to develop an explicit vision on liability in case of improper use of data or models.

*Uncertainty, Communication & Trust*

From a scientific perspective, methods and uncertainties are sufficiently transparent. However, for a less specialised audience and for the general public, this information is often difficult to read. Different audiences need different ways of communicating uncertainties and, in general, MIL could improve on providing more targeted, balanced and differentiated information to specific groups in a clear and understandable way. Within MIL, there are already good examples, and the various programmes within MIL could learn from each other. The AC appreciates very much the way the Minerals Monitoring Programme interacts with LMM participants (farmers) and provides information through its newsletter. The LMM has a communication strategy which, in interaction with the commissioning Ministry LNV,

is also regularly renewed including an inventory of means of communication and an evaluation on the question whether the different aims and stakeholder groups were sufficiently addressed.

At the same time MIL could be more aware that, especially in contested policy settings, more technical details and transparency do not automatically lead to more public trust. The understandable and deeply rooted conviction that transparency builds trust, is not supported by evidence. Far more important are a reputation of neutrality and authority. Support of a particular side in a conflict may threaten the perceived neutrality, thereby also lowering the value of scientific advice as basis for policy.

The burden of evidence, the level of uncertainty in science advice, as well as the nature of uncertainty communication depend on the policy uses of science advice. Routine monitoring, licensing, the assessment of policy goal achievement, or norm transgression require different approaches to uncertainty and trust building. The laudable awareness that models need to be fit for purpose requires also a deeper reflection on the precise nature and consequences of the policy purpose.



## 4 Recommendations

### 4.1 General Conclusions and Answers to Key Questions

#### *General Conclusions*

Overall the AC concludes that 1) in general MIL monitors what is needed for national and regional environmental policy making in a robust way; 2) MIL methods are fit for purpose on the national and regional level. At the same time, MIL could be less hesitant in pointing out to all users and the general public when it considers the use of these methods beyond the range of application (e.g. at lower and more spatial detailed levels); 3) in order to be sufficiently prepared for emerging issues and developments, MIL should give more priority to its own research agenda and knowledge base in close cooperation with universities and other research institutes. In general MIL could be acting more pro-active in convincing the ministries that also methodology development should be commissioned. This would increase both MIL's policy relevance and independence. Innovation is in the interest of the quality of compulsory and routine products and cooperation with others will improve the quality and acceptance of results, while reducing the vulnerability of MIL output.

#### *Answers to Key Questions*

1. *Relevance and readiness for the future:* Is MIL sufficiently able to effectively and timely support policy processes? What should be strengthened in order to be ready for increasingly complex issues?

The work of MIL is highly relevant and MIL is currently sufficiently able to effectively and timely support policy processes. The monitoring work is highly appreciated by national policymakers and other users, including users of data at other research institutes. At the same time, MIL experiences that the priority for routinely monitoring and standard reporting, required by national and international obligations, limits both (scientific) innovation and a necessary shift towards the analysis of new issues and more integral approaches. Currently there is not enough time and budget allocated to really look forward. The AC strongly recommends to give more priority to an own research agenda and strengthening the knowledge base in order to be able to anticipate, not only on new issues, but also to stay up to date regarding innovation in current monitoring. Doing so in cooperation with other research institutes could be a way to invest precious time efficiently.

2. *Interaction with policy and society:* Is policy advice of MIL independent and robust given scientific uncertainties? Is our interaction with policy and society in balance, given the trend towards multilevel governance?

Within MIL there is a high commitment and motivation to deliver impartial and reliable policy-relevant information. Scientific integrity is taken very seriously and MIL employees feel a high responsibility for the quality of the results. At the same time, and given the high commitment to deliver, MIL experiences a delicate balance between maintaining an independent position and delivering policy-relevant results. Because time is either needed for commissioned work following routines, or is devoted to additional questions asking for quick reactions, there is not felt much room for an own research agenda and methodology development or reflection on methodology. MIL could be more proactive in defending this room, as this is in the interest of the quality of the routine work as well as of the answering and assessment of the feasibility of additional requests. A clear vision on the role of MIL in a changing societal context is needed to be able to position itself and making conscious choices vis-à-vis increasing requests for more interaction with policy makers, more advice and help with implementation at multiple governance levels. Such a vision can support the division of labour with collaborating partners and the

exploration of new methodologies. The increased use of citizen science and public involvement is applauded.

3. *Research, quality assurance & scope of application:* Where could scientific quality and quality control be improved? How can we better communicate about sound application ranges of models and data sets (given increasing demand for spatial detail and use in juridical settings)?

While within MIL there is a high awareness of the importance of research and technical quality, external review of MIL reports is currently limited and, with a few highly valued exceptions, visibility of MIL experts and MIL work in academic journals and networks is relatively low. Research quality (scientific credibility) could be enhanced by increased emphasis on publications in international scientific journals and by enhancing close cooperation with national and international research groups outside RIVM. Finding ways to combine commissioned reporting with scientific publishing, and contributing to consortium publications could be a way to invest precious time efficiently and enhance the support base. The MIL management has expressed a keen interest in cooperation with universities and other institutions but in general MIL could be less hesitant in cooperation with others and view cooperation less as a risk (uncontrollable factors, feeling responsible) and more as an opportunity. Cooperation with other research institutes will help to take a stronger stand in communication about what is possible and not, e.g. with regard to spatial detail and use in juridical settings.

4. *Transparency:* Are models and data sufficiently publicly available (FAIR: Findable, Accessible, Interoperable, Reusable) and how can correct application be ensured? Are we sufficiently transparent about methods and uncertainties?

In recent years substantial efforts have been undertaken to document basic assumptions in MIL models and to make data publicly available. Overall, models are relatively FAIR and can be found on the internet and in the grey literature. From a scientific perspective, methods and uncertainties are sufficiently transparent. However, for a less specialised audience and for the general public this information is often difficult to read. Different audiences need different ways of communicating uncertainties and MIL could improve on providing targeted information also in order to ensure correct application.

## **4.2 Strategic Recommendations for the Near Future**

**1. Dare to make choices and as a consequence sometimes say no.** Hold on to your strengths and specific niche in environmental expertise for public policy-making: measuring & modelling (including development of methods), interpretation, signalling, reporting and policy advising. Avoid to get involved in executive tasks as related to policy implementation, permitting and compliance.

**2. Invest time and resources in international academic journal publications, accompanied by targeted summaries in Dutch, accessible through relevant media.** Invest in clear and concise communication and differentiated ways of communicating uncertainties.

**3. Develop a vision with regard to MIL's position and role in the Dutch and international "landscape of expertise" and the necessary research infrastructure – both in-house and distributed –, including the scope of application of current MIL methods, tools and methodological perspectives for specific policy uses.** In order to do so, make sure that relevant expertise on policy science is onboard.

- Use this vision to decide which tasks to embark on and which to avoid or abandon: different policy and legal settings ask for different evidence standards. Be clear and consistent about which methods are "fit" for which "purpose". Collaborate also with others, such as the PBL, on clarifying lowest boundaries with regard to the use of nitrogen-deposition modelling in permitting.
- Use this vision to decide on the course of methodology development and innovation, on investment of time and resources in international research networks, joining European research projects and global programmes.
- Use this vision to underpin the discussion with commissioners for the needed resources (including possibilities for co-funding). Be explicit on the MIL research agenda and needs when interacting with commissioners.
- Use this vision to intensify cooperation with Dutch Universities and with other relevant (RKI and TO2) research institutions such as PBL, TNO and Deltares with the purpose of joint knowledge development. Ensure in this cooperation to collaborate as equal partner respecting the role and position of the other partners. Use the current momentum of shared research projects like the National Nitrogen Research programme (NKS) programme and infrastructure programmes like Faciliteiten Toegepast onderzoek (FTO) and Grootschalige Wetenschappelijke Infrastructuur (GWI) to further enhance cooperation.
- The vision on MIL's specific niche will support the division of labour with collaborating partners. In some cases, a partner in the network might be able to pick up certain questions, in other cases the academic network as a whole could show that some questions cannot be answered by more scientific detail and need other forms of deliberation.

**4. Keep investing time and resources to participate and be visible in EU policy making and international bodies** like EEA, UN-ECE, LRTAP, OECD, WHO and others. Make sure that retiring MIL experts are replaced timely and knowledge and contacts are transferred to colleagues. An active international role of MIL experts is crucial for the development of relevant knowledge for environmental policy making in the Netherlands.

## **Appendix I      Site visit programme 21-22 December 2023**

### **Wednesday 20 December**

Informal dinner to introduce members of the AC and the MT-MIL to each other

### **Thursday 21 December**

#### **9.00-9.30u: Explanation background audit by SAB**

SAB members Frans Russel and Carolien Kroeze

#### **9.30- 10.45u**

#### **Welcome by Joost Damen, Head MIL**

#### **Short introductions on the application of MIL-knowledge in policy processes**

- Margreet van Zanten: Policy support Emission Registration
- Susanne Wuijts: EU Nitrates Directive and Water Framework Directive (KRW) – From monitoring to policy advice
- Ella Westerhoff: Evaluation National Programme for Rural Areas
- Henri de Ruiter: Support of local participatory processes

*Present: Charles Wijnker (Director Environment & Safety)*

*Management Team (MT): Joost Damen, Corry Brooijmans, Jappe Beekman, Kitty de Bruin, Benjamin Rietveld*

#### **11.00-12.30u: Dialogue with MT-MIL on governance & strategy MIL**

#### **13.30-17.30u: Dialogue with project team MIL-audit**

- Emission Registration: Margreet van Zanten, Corry Brooijmans
- Air Quality modelling: Ronald Hoogerbrugge, Joost Wesseling, Guus Velders, Kitty de Bruin
- Air Quality monitoring network: Dennis Mooibroek, Guus Velders
- Nitrogen deposition monitoring & modelling: Addo van Pul, Wouter Marra, Wim van der Maas (online), Corry Brooijmans
- Water Quality Monitoring: Susanne Wuijts, Richard van Duijnen, Floris Naus, Jappe Beekman
- Data Management: Job Spijker

### **Friday 22 December**

#### **9.00-11.30u: Dialogue based on 4 Central Questions**

- MIL Modelling Strategy: Guus Velders
- Innovation: Guus Velders, Wouter Hendricx
- Knowledge Base Strategy: MT MIL; presentation online by Thomas van Goethem and Wim van der Maas

**11.30-12.30u Interaction of AC with junior staff:** Tamara van Bergen, Timo Brussée, Lennart Bouma, Richard van Duijnen, Sebastiaan Hazelhorst, Maaïke Lammerts-Huitema, Pim Meijer, Lisa Tostrams

#### **13.30-15.30u: Audit committee prepares preliminary conclusions**

**16.00-16.30u: Drinks and first informal feedback AC in (online) presence of the SAB Liaisons**

## Appendix II Quantitative data on staff capacity, output, funding

### Staff

2021: 133 fte

2023: 160 fte (10% support staff; 2 professors)

### Output

Regular monitoring reports and web products

### Academic publications

Average 2019-2023: 22 per annum

### Funding and costs

Research funding	Annual average personnel costs 2020-2024 (m Euro)	
direct funding	IenW	21,1 63%
	LNV	9,2 27%
	EZK	0,5 1%
research grants	SPR/NWO/OCW	1,3 4%
contract research	European Commission	0,6 2%
	Regional/local governments	0,8 2%
total personnel costs		33,5 63%
Other costs		20,0 37%