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**Report for the Stage 3 *ad-hoc* review of emission
inventories submitted under the UNECE LRTAP
Convention:**

2023

North Macedonia

FINAL REPORT

CONTENT

INTRODUCTION	3
PART A: GENERAL RECOMMENDATIONS FOR THE CHAPTER AGRICULTURE.....	5
PART B: SPECIFIC RECOMMENDATIONS FOR THE SECTOR AGRICULTURE.....	6
PART C: SPECIFIC RECOMMENDATIONS FOR THE GRIDDED EMISSION DATA FOR THE SECTOR AGRICULTURE.....	11
LIST OF MATERIALS PROVIDED TO ERT.....	13
LIST OF ADDITIONAL MATERIALS PROVIDED BY THE COUNTRY DURING THE REVIEW	13
ABBREVIATIONS.....	15
LIST OF REFERENCES AND SUPPORTING DOCUMENTS.....	17

INTRODUCTION

1. The mandate and overall objectives for the emission inventory review process under the LRTAP Convention is given by the UNECE document 'Updated methods and procedures for the technical reviews of air pollutant emission inventories reported under the Convention'⁽¹⁾ – hereafter referred to as the 'Review Guidelines 2018'.
2. Paragraph 7 (c) of the 'Review Guidelines 2018' defines that Stage 3 Reviews may be annual centralized reviews or ad hoc reviews. Paragraph 18 of the 'Review Guidelines 2018' further specifies that such ad hoc reviews could, for instance, focus on specific source sectors, specific pollutants such as heavy metals or persistent organic pollutants, gridded and projections data, or on other areas as requested by the Implementation Committee and that where appropriate, ad hoc reviews could be conducted in line with the present Methods and Procedures for the In-depth (Stage 3) review.
3. At its eighth joint session in September 2022, the Steering Body and the Working Group on Effects approved the plan that the in-depth review in 2023 focuses on emissions from agriculture with a special emphasis on ammonia, NMVOC and NO_x emissions including gridded data. While the focus was set on NH₃, NMVOC and NO_x emissions, also all other pollutants covered by LRTAP Convention and its protocols (i.e. SO₂, NO_x, NMVOC, NH₃, plus PM₁₀ PM_{2.5}, BC, priority HMs and POP_S) have been checked for the time series years 1990 – 2021 to the extent possible. For these other pollutants especially completeness of reporting was assessed.
4. This report covers the results of the Stage 3 Review (ad hoc review) 2023 of North Macedonia air emission inventory submitted under the UNECE LRTAP Convention. The review was coordinated by the EMEP Centre on Emission Inventories and Projections (CEIP) acting as Review Secretariat. The review took place between April and June 2023 and was performed as a desk review between 31 March to 5 May 2023 and an in-person meeting between 22 of May 2023 and 26 May 2023 (centralized review). The following team of nominated experts from the Roster of Experts performed the review.

Agriculture experts:

Ms. Armine ARTENYAN (Republic of Armenia)

Ms. Ajla BASOVIC (Montenegro)

¹ Decision 2018/1 adopted by EB: *Updated methods and procedures for the technical review of air pollutant emission inventories reported under the Convention*. ECE/EB.AIR/142/Add.1
http://www.unece.org/fileadmin/DAM/env/documents/2002/eb/air/EB%20Decisions/Decision_2018_1.pdf

Ms. Aleksandra NESTOROVSKA-KRSTESKA (North Macedonia)

Mr. Lasha AKHALAIA (Georgia)

Mr. Hakam AL-HANBALI (Sweden)

Ms. Susana LOPEZ-APARICIO (EU/RTC(EEA))

Ms. Simone MAYER (Austria)

Ms. Andjelka RADOSAVLJEVIC (Serbia)

Ms. Kristina Tonhauzer (Slovakia)

Mr. Tim VAN DER ZEE (Netherlands)

Experts for gridded emission data:

Ms. Christine BRENDLE (Austria)

Mr. Christopher EVANGELIDES (United Kingdom)

Mr. Christian MIELKE (Germany)

5. Mr. Ben RICHMOND (United Kingdom), Ms. Rikke ALBREKTSEN (Denmark), Mr. Etienne MATHIAS (France), Ms. Kristina SAARINEN (Finland) were the lead reviewers. The review was coordinated by Ms. Sabine Schindlbacher and Mr. Bernhard Ullrich (EMEP Centre on Emission Inventories and Projections - CEIP).

6. The review was performed on the basis of CLRTAP emission data officially reported by North Macedonia, due by 15 February 2023. The Informative Inventory Reports (IIR), reported due by 15 March 2023 under the CLRTAP, informed the review.

7. The EMEP/EEA Guidebook 2019² was used as a base for the review.

8. The emission inventory of North Macedonia was received on 14 February 2023 and thus by the deadline of 15 February. The Informative Inventory Report was received on 7 April 2023 and thus not by the deadline of 15 March. North Macedonia provided a resubmission of the emission inventory on 6 March 2023. This resubmission has been considered for the review.

² EMEP/EEA: EMEP/EEA air pollutant emission inventory guidebook 2019, EEA Report No. 13/2019 European Environment Agency, Copenhagen. Available at: <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019> EU 2019

PART A: GENERAL RECOMMENDATIONS FOR THE CHAPTER AGRICULTURE

9. The ERT recognises the level of effort undertaken by North Macedonia in providing an inventory including a significant level of detail.

10. The IIR describes the methods used for the sector of agriculture overall transparent, but some issues were identified during the review process. The ERT considers the agriculture part of the inventory submission to be of adequate quality in terms of completeness and of adequate quality in terms of accuracy, comparability and consistency.

To improve the overall quality of the agriculture air emission inventory the ERT recommends North Macedonia to

- provide a detailed description of applied methodologies, data sources, choice of emission factors and activity data for all categories in the IIR.
- apply a Tier 2 or higher method to all key categories.
- use the latest available version of the EMEP/EEA air pollutant emission inventory guidebook 2019.
- ensure that the agriculture emission inventory is complete.
- ensure that also emissions of the following pollutants are included: NO_x and ammonia from 3Da2c Other organic fertilizers.
- provide a better description of the methods used for gridding of emission data in future submissions
- increase the capacities of the air pollution inventory team in order to manage transparent, complete, comparable, consistent and accurate inventory within deadlines set up in the UNECE reporting Guidelines.
- provide detailed information on its QA/QC plan for its air emission inventory in future submissions.

PART B: SPECIFIC RECOMMENDATIONS FOR THE SECTOR AGRICULTURE

11. Table 1 provides the findings from the 2023 CLRTAP Stage 3 Review including those not implemented from previous CLTRAP Stage 3 Reviews. While the focus was set on NH₃, NMVOC and NO_x emissions, also all other pollutants covered by the LRTAP Convention and its protocols (i.e. SO₂, NO_x, NMVOC, NH₃, plus PM₁₀ PM_{2.5}, BC, priority HMs and POP_s) have been checked for the years 1990 – 2021 to the extent possible, especially regarding the completeness of reporting. The implementation of the recommendations will be followed up in a future CLRTAP inventory review.

Table 1: Findings from the CLRTAP Stage 3 Review 2023 for the Sector Agriculture³

ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
MK-2023-3B-1	NH ₃	3B	Yes	Tier 1	R	A

Observation

The ERT note that emissions from manure management is a key source of NH₃ emissions in North Macedonia; this is a subsection of agriculture, from which 90% of NH₃ emissions arise (Chapter 5.1, p234). In the 2023 submission, NH₃ emissions are currently estimated using a Tier 1 methodology, whilst key categories should use a Tier 2 or higher method. During the last Stage 3 Review conducted in 2016, North Macedonia stated that the Tier 2 method will be implemented in the coming years. During the review, the Party provided information on projects which are in progress, which will implement a higher Tier method in the 2025 submission.

Recommendation

The ERT recommends North Macedonia to use a Tier 2 or higher method for the calculation of NH₃ emissions from 3B by the 2025 submission. Changing to a Tier 2 method can be facilitated by the use of the N-flow tool available at <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/4-agriculture/manure-management-n-flow-tool/view>

³ Note: There are four possible types of findings: R: Recommendation, TC: Technical Correction, PTC: Potential Technical Correction; RE : Revised Estimate

The findings have been assigned to one or more of the following criteria: TACCC T (Transparency), A (Accuracy), C₁ (Completeness), C₂(Comparability), C₃ (Consistency) for definitions of these criteria see EMEP/EEA Guidebook 2019

ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
MK-2023-3B-2	NMVOG	3B1a, 3B1b	Yes	Tier 1	R	A

Observation

The ERT note that NMVOG emission from 3B1a dairy cattle and 3B1b are key sources of emissions (IIR p.299, table 212). In the 2023 submission, a Tier 1 methodology was used. The key sources (level and trend) of emissions should be estimated using the Tier 2 method provided in the latest version of the EMEP/EEA Guidebook. During the review, the Party provided information on ongoing projects to implement a higher Tier method in the 2025.

Recommendation

The ERT recommends North Macedonia to use a Tier 2 or higher method for the calculation of NMVOG emissions from 3B1a Dairy Cattle and 3B1b Non-dairy cattle by the 2025 submission.

ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
MK-2023-3B-3	All pollutants	3B	Yes	-	R	AC ₃

Observation

The ERT noted that North Macedonia used different versions of the EMEP/EEA Guidebook for the estimation of emissions across the time series. This issue is connected with the consistency of the methodology used. During the review, the Party confirmed that there is a plan to unify emission estimates with the 2019 EMEP/EEA Guidebook under the scope of the planned TAEIX expert mission/IPA II project.

Recommendation

The ERT encourages North Macedonia to use the latest version of the EMEP/EEA Guidebook for the estimation of emissions for the whole timeseries, and implement this as soon as possible.

ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
MK-2023-3Da1-1	NO _x	3Da1	Yes	Tier 1	R	TA

Observation

The ERT noted that North Macedonia uses emission factors for the calculation of NO_x emissions Tier 1 methodology based on the 2016 EMEP/EEA Guidebook. However, the quoted emissions factors used (IIR p.248 table 170) for the calculation of 3Da1 Inorganic fertilization

are not in line with 2016 EMEP/EEA Guidebook. During the review, the Party stated that at present, the implemented emission factors are in line with the 2013 EMEP/EEA Guidebook, Table 3.1.

Recommendation

The ERT recommends that the Party clearly document the procedure used to calculate emissions from NFR 3Da1, Inorganic N-fertilisers. It is also recommended that the Party should use a Tier 2 method from the latest version of the EMEP/EEA Guidebook, which provides more accurate emission factors based on best practices for estimating emissions for a sector which is a key category.

ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
MK-2023-3De-1	NMVOG	3De	Yes	Tier 1	R	A

Observation

The ERT noted that NMVOG emissions from 3De Cultivated crops are a key source of emissions (IIR p.299, table 212). The 2023 submission from North Macedonia uses a Tier 1 methodology. Key sources (level and trend) of emissions should be estimated using the Tier 2 method provided in the latest version of the EMEP/EEA Guidebook. During the review, the Party provided information regarding ongoing projects to implement higher Tier methods in the 2025 submission.

Recommendation

The ERT recommends North Macedonia to use a Tier 2 or higher method for the calculation of NMVOG emissions from 3De, Cultivated crops and provided the transparent description of the methodology in North Macedonia IIR by the 2025 submission.

ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
MK-2023-3Da2c-1	NO _x , NH ₃	3Da2c	-	-	R	AC ₁

Observation

The ERT noted that for NO_x and NH₃ emissions from 3Da2c Other organic fertilizers in the years 1990-2021, NA was reported while a Tier 1 method is available in the 2019 EMEP EEA Guidebook. The Party explained that this category is not reported due to missing emission factors in the 2013 EMEP EEA Guidebook and an explanation for the use of the notation key was found in the IIR p. 235, chapter 5.2. During the

review, the Party declared that emission estimation from this category will be made as part of the TAEIX expert mission that is planned for 2024. Therefore, the emissions from this category will be submitted in the next submission or in 2025 as part of the IPA II project.

Recommendation

The ERT recommends North Macedonia to report NO_x and NH₃ emissions from 3Da2c of Other organic fertilizers in the 2024 submission using a Tier 1 method, using emission factors available in the 2019 EMEP/EEA Guidebook.

ID	Pollutants	NFR category	Key Category	Tier level	Type	TAC ₁ C ₂ C ₃
MK-2023-3Df-1	HCB	3Df	No	-	R	T

Observation

The ERT noted that HCB emissions from pesticides (3Df) are not reported while a Tier 1 method is available in the 2019 EMEP EEA Guidebook. No explanation for the use of the notation key “NO” was found in the IIR (p235). During the review, the Party provided an explanation about using pesticides in North Macedonian Agriculture and provided a National Implementation Plan for the reduction and elimination of POPs substances in North Macedonia. During the review it was stated that HCB is not used in North Macedonia presently, although it was until 1965.

Recommendation

The ERT recommends North Macedonia to provide a transparent description of the use of the notation key “NO”, providing all relevant documentation in the 2024 submission of the IIR.

PART C: SPECIFIC RECOMMENDATIONS FOR THE GRIDDED EMISSION DATA FOR THE SECTOR AGRICULTURE

12. For the 2023 Review of the gridded emission data the focus was set on NH₃, NMVOC, NO_x and PM_{2.5} emissions.
13. The methods used by North Macedonia to spatially resolve sectoral emissions are not described transparently enough in the IIR. The ERT notes that North Macedonia specifically acknowledges in the IIR that there is room for improvement of the gridding chapter and that it is planned to implement these in future submissions.
14. The description includes data sources that have been used for spatial distribution.
15. Gridded emissions reported for GNFR K_AgriLivestock and L_AgriOther are consistent with the corresponding NFR categories reported in Annex I.
16. Table 2 provides the findings from the ERT related to the gridded data.
17. The implementation of the recommendations will be followed up in a future CLRTAP inventory review. Future recommendations on further future improvements may be given in follow up CLRTAP reviews.

Table 2: Findings from the CLRTAP stage 3 review 2023 for gridded emissions from the sector agriculture⁴

ID	Pollutants	GNFR category	TAC ₁ C ₂ C ₃
MK-2023-GRID-GL-1	All supplied	GNFR-K&L	T
<p>Observation The ERT notes with reference to the gridded emission inventory North Macedonia provided an IIR chapter on gridding with limited information. North Macedonia acknowledged that there is room for improvement in documenting the methods and data used for the gridding of emissions in the IIR. During the review, North Macedonia provided data relating to the twinning project for transparency.</p> <p>Recommendation The ERT recommends that North Macedonia continues to improve its IIR gridding chapter as suggested by the party.</p>			

⁴ The findings have been assigned to one or more of the following criteria: TACCC T (Transparency), A (Accuracy), C₁ (Completeness), C₂ (Comparability), C₃ (Consistency) for definitions of these criteria see EMEP/EEA Guidebook 2019

LIST OF MATERIALS PROVIDED TO ERT

1. North Macedonia Annex I reporting template
2. North Macedonia Stage 2 S&A report
3. North Macedonia Stage 1 report 2023
4. North Macedonia IIR 2023
5. Repdab-Report
6. Extended checks

LIST OF ADDITIONAL MATERIALS PROVIDED BY THE COUNTRY DURING THE REVIEW

1. Responses to the question raised by ERT during the review
2. Material received from the Party during the Review
 - Twinning project mission report, Further Strengthening the capacities for effective implementation of acquis in the field of air quality, Finnish Meteorological Institute.

REVISED ESTIMATES AND TECHNICAL CORRECTIONS CONSIDERED AND/OR CALCULATED BY ERT

In the Appendix of the 'EMEP/UNECE Review Guidelines 2018'⁴ it is stated that if the ERT considers that emissions are significantly under- or overestimated, the Party is during the review invited to submit 'Revised Estimates' that address the issue raised. Should the Party decline to do this, or should it not be possible to agree on the quantification of a Revised Estimate i.e. the ERT does not accept a Revised Estimate provided by the Party, the ERT may calculate a 'Technical Correction'. The threshold for significance for a Technical Correction for the in-depth review in 2023 was set at 2% of the national total, i.e. a finding that has been identified to result in an over- or underestimate of emissions of more than 2% of the national total. The methods for calculating Technical Corrections are set up in the 'EMEP/UNECE Review Guidelines 2018' and use the EMEP/EEA Emission 'Inventory Guidebook' as a reference for methods and emission factors.

The ERT did not calculate any Technical Corrections and North Macedonia did not provide any Revised Estimates.

ABBREVIATIONS

This list includes abbreviations commonly used in the Review Reports

AD	Activity data
BaP	Benzo[a]pyrene
BC	Black Carbon
C	Confidential
Cd	Cadmium
CEIP	Centre on Emission Inventories and Projections
CLRTAP	Convention on Long-range Transboundary Air Pollution – ‘the Air Convention’
CO	Carbon Monoxide
E-PRTR	European Pollutant Release and Transfer Register
EEA	European Environment Agency
EF	Emission factor
EMEP	The co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (unofficially ‘European Monitoring and Evaluation Programme’ = EMEP)
ERC	Emission Reduction Commitment
ERT	Expert Review Team
GHG	Greenhouse gas
GIS	Geo Information System
GNFR	NFR Aggregation for Gridding and LPS
HCB	Hexachlorobenzene
Hg	Mercury
HM	Heavy metals
IEF	Implied emission factor
kt	Kilotonnes
LPS	Large Point Sources
NA	Not applicable
NE	Not Estimated
NECD	National Emission reduction Commitments Directive
NFR	Nomenclature for reporting
NH ₃	Ammonia
NMVOC	Non-methane volatile organic compounds
NO	Not Occuring
NO _x	Nitrogen oxides
NR	Not relevant/Not Reported
PAHs	Polycyclic aromatic hydrocarbons
Pb	Lead
PCB	Polychlorinated biphenyls
PCDD/F	Polychlorinated dibenzo-p-dioxins and dibenzofurans
PM ₁₀	Fine particulate matter: particles with an aerodynamic diameter equal to or less than 10 micrometres (µm)

PM _{2.5}	Fine particulate matter: particles with an aerodynamic diameter equal to or less than 2.5 micrometres (µm)
POPs	Persistent organic pollutants
PTC	Potential technical correction
RE	Revised estimate
SO ₂	Sulphur dioxide
SO _x	Sulphur oxides
TC	Technical correction
TSP	Total suspended particulates

LIST OF REFERENCES AND SUPPORTING DOCUMENTS

1. Annex I emission reporting template. Available at <https://www.ceip.at/reporting-instructions>
2. ECE/EB.AIR/111/Add.1: Decision 2012/3: Adjustments under the Gothenburg Protocol to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them
https://unece.org/DAM/env/documents/2013/air/ECE_EB.AIR_111_Add.1_ENG_DE_CISION_3.pdf
3. ECE/EB.AIR/113/Add.1: Decision 2012/12: Guidance for adjustments under the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them
https://unece.org/DAM/env/documents/2012/EB/Decision_2012_12.pdf
4. ECE/EB.AIR/125: 2014 Reporting Guidelines for Estimating and Reporting Emission Data under CLRTAP
https://unece.org/fileadmin/DAM/env/documents/2013/air/eb/ece.eb.air.125_E_ODS.pdf
5. ECE/EB.AIR/127/Add.1: Decision 2014/1: Improving the guidance for adjustments under the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to emission reduction commitments or to inventories for the purposes of comparing total national emissions with them
https://unece.org/DAM/env/documents/2014/AIR/EB/Decision_2014_1.pdf
6. ECE/EB.AIR/130: Technical Guidance for Parties Making Adjustment Applications and for the Expert Review of Adjustment Applications, 14 April 2015
https://unece.org/DAM/env/documents/2014/AIR/EB/ECE_EB_AIR_130_ENG.pdf
7. [ECE/EB.AIR/142/Add.1: Decision 2018/1: Updated methods and procedures for the technical reviews of air pollutant emission inventories reported under the Convention](https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2019/decision_2018_1_advance_version_ece_eb.air_142_add.1.pdf)
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9. EMEP/EEA: EMEP/EEA air pollutant emission inventory guidebook 2019, EEA Report No. 13/2019 European Environment Agency, Copenhagen. Available at: <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019>
10. TFEIP (2022): "Inventory adjustments in the context of emission reduction commitments (ERC)" available at: https://www.ceip.at/fileadmin/inhalte/ceip/00_pdf_other/2022/technical_guidance_for_erc_adjustments_issue1.1.pdf