Project Number 282910

ÉCLAIRE

Effects of Climate Change on Air Pollution Impacts and Response Strategies for European Ecosystems

Seventh Framework Programme

Theme: Environment

D19.4 Final Report on the development and scenario application of methods.

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Organisation name of lead contractor for this deliverable :
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PU	Public	☐
PP	Restricted to other programme participants (including the Commission Services)	☒
RE	Restricted to a group specified by the consortium (including the Commission Services)	☐
CO	Confidential, only for members of the consortium (including the Commission Services)	☐

1. Executive Summary

The objectives of WP19 have been achieved.

The focus in the reporting period was on the development and testing of methods and possible indicators to assess exceedances of "critical loads for biodiversity" (CL_{bio}) in Europe. Under component C4 and C5 novel critical loads for biodiversity have been derived from the Habitat Suitability Index (see D16.4), and implemented in the GAINS system.

The method was presented and reviewed (**following –WP19/MS85**) to the community of the International Cooperative Programme on Modelling and Mapping critical levels and loads and air pollution effects, risks and trends (ICP M&M), at the 25th CCE workshop hosted by the Croatian Meteorological Institute (Zagreb, 20-23 April 2015, http://www.wge-cce.org/Activities/Workshops/Past_workshops/Croatia_2015). A common session was held addressing methods developed under C4 and C5 of the ECLAIRE project and the progress under the Convention, as contribution to the Component 5 meeting (**following-WP19/MS93**; Laxenburg, 29-30 June 2015; http://user.iiasa.ac.at/~winiwart/ECLAIRE_June_2015/).

Exceedances of the critical loads for biodiversity have been assessed for 4 different scenarios in which measures to abate air pollution and, the two last scenarios in particular, to also curb climate change (D20.6) i.e. "Current Legislation in 2010" (CLE2010), "Current Legislation in 2050, "Decarbonisation in 2050" (DECARB), and Maximum Control Effort in 2050" (MCE).

The European critical loads database for biodiversity, developed under C4 and C5 of the ECLAIRE project, now completes two already existing GAINS system impact indicators, i.e. the European critical load database of critical loads for eutrophication (CL_{nut}; Hettelingh *et al.*, 2015a) and empirical critical loads (CL_{emp}; Hettelingh *et al.*, 2015b). The European database of CL_{nut} is based on geo-chemical parameters, while CLemp has been compiled based on field measurements of impacts of nitrogen deposition (Bobbink and Hettelingh, 2011; Bobbink *et al.*, 2015).

Results, described in this report, indicate that nitrogen deposition puts important parts of European ecosystems at risk because of the exceedance of critical loads. The area at risk varies depending of which critical load is used.

Finally, CL_{bio}, CL_{nut} and CL_{emp} are used to assess the robustness analysis (Hettelingh *et al.*, 2015a) of ecosystem impacts of GAINS scenarios. It is based on the analysis of the location and magnitudes of exceedances of various critical thresholds, following the principle of "ensemble modelling".

1. Objectives:

Objectives under WP19 are:

(1) To operationalize new critical thresholds for the GAINS assessment of adverse effects of air pollution abatement scenarios (incl. climate change) on plant species diversity and ecosystem services
(2) To provide operational indicators for the support of policy with the assessment of scenario-specific adverse effects
(3) To analyse the robustness, the magnitude and location of scenario specific adverse effects on a regional scale.

2. Activities under D19.4:

Progress in the development of the HIS index and critical loads for biodiversity has been reported (Slootweg et al., 2014). An overview of methods underpinning the development, application and future of critical loads and dynamic modelling has recently been published (De Vries *et al.*, 2015)

Task 19.1 New Critical thresholds

Progress was made in the development of a novel indicator, the “habitat suitability index” (HSI) developed in collaboration with ECLAIRE-C4 and the community of the ICP M&M at the CCE workshop under the auspices of the LRTAP Convention, hosted by the Croatian Meteorological Institute (MS85; Zagreb, 20-23 April 2015).

Critical loads for biodiversity (CL_{bio}) have been compiled in Europe for 23 habitats (see D15.4), in about 1.3 million ecosystem data points, covering around 2.4 million km^2 including various classes following the EUropean Nature Information System (EUNIS; Davies and Moss 1999).

This database of new critical thresholds (see objective 1) has led to a “European critical loads for biodiversity” (CL_{bio}) which completes the already existing databases available at the CCE of “ European critical loads for acidification and eutrophication” (CL_{nut}) and of “European empirical critical loads (CL_{emp}).

Task 19.2 Dynamic modelling:

The PROPS model (C4) has been applied to compute the critical loads for biodiversity (CL_{bio}) on a Europeaan scale. Use is also made of the *background database* on soil chemistry (see also Posch and Reinds, 2005) and EUNIS vegetation for application under ECLAIRE in a collaboration between C4 and C5. This background database is consistent over Europe and may be employed in addition to – or instead of – country specific data submissions. The latter will be reviewed at the 34th session of the Working Group on Effects in 2015, i.e. at the end of the ECLAIRE project..

Task 19.3 Dose response relationships

This task addresses the use in GAINS system scenario analysis of relationships in European natural areas between scenario specific nitrogen dose in combination with climate change. Critical loads for biodiversity have been developed, implemented in the GAINS system and applied to assess effects of emissions and related depositions that are distinguished in 4 different scenarios of measures to abate air pollution and curb climate change (see a detailed description in D20.6) . These scenarios are “Current Legislation in 2010” (CLE2010), “Current Legislation in 2050, “Decarbonisation in 2050” (DECARB), and Maximum Control Effort in 2050” (MCE).

Results include, maps of exceedances of CL_{bio} shown in para 3.

Task 19.4 Robustness analysis of GAINS scenario impacts on a regional scale

The robustness of exceedances is derived in this section in analogy to the way in which uncertainties are addressed in the Fourth Assessment Report of the IPCC, as described in IPCC (2005). In this logic, the robustness of an assessment that ecosystem areas are at risk can range on a scale from “exceptionally unlikely” to “virtually certain”.

Robustness analysis of ecosystem impacts of the 4 GAINS scenarios (see task 19.3), is based on the analysis of the location and magnitudes of exceedances of three different critical loads. The European critical loads database for biodiversity, developed under C4 and C5 of the ECLAIRE project, now completes two already existing GAINS system impact indicators, i.e. the European critical load database of critical loads for eutrophication (CL_{nut}; Hettelingh *et al.*, 2015a) and empirical critical loads (CL_{emp}; Hettelingh *et al.*, 2015b). The European database of CL_{nut} is based on geo-chemical parameters, while CL_{emp} has been compiled based on field measurements of impacts of nitrogen deposition (Bobbink and Hettelingh, 2011; Bobbink *et al.*, 2015).

The ECLAIRE deliverable, i.e. CL_{bio} are used in conjunction with critical load databases already included in the GAINS system, i.e. CL_{nut} and CL_{emp} to assess the robustness analysis (Hettelingh *et al.*, 2015a) of ecosystem impacts of GAINS scenarios.

The method is based on the analysis of the location, coverage and magnitudes of exceedances of various critical thresholds, following the principle of ensemble assessment (Hettelingh *et al.* 2015a) whereby a phenomenon (i.e. exceedances) is more likely when it occurs using different methods (i.e. three types of critical loads). *Robustness analysis would be geared around the question whether nitrogen deposition causes* scenario specific impact indicators to point in the same direction. The availability of three different endpoints (soil chemistry, plant species diversity and habitat Suitability) leads to three types of critical loads, each of which can be exceeded. This leaves an ecosystem area with the following possibilities of being at risk of atmospheric deposition of nitrogen:

1. None of the critical loads are exceeded
2. One single type of critical load is exceeded
3. Two types of critical loads are exceeded
4. Three types of critical loads are exceeded:
   a. with a likelihood in the interval [0, 0.33] ; i.e the ecosystem is “likely” to be at risk
   b. with a likelihood in the interval [0.33, 0.66]; i.e. the ecosystem is “very likely” to be at risk
   c. with a likelihood > 0.67; the ecosystem is “virtually certain” to be at risk.

We state the likelihood of an exceedance in an EMEP grid cell as being likely, very likely or virtually certain if the cube root of the product of the percentages of protected ecosystem areas based on CL_{nut}, CL_{emp} and CL_{bio} are in ranges of 0-33, 33-67 and >67% (Hettelingh*et al.*, 2015a).
It is assumed that none of the three types of critical loads is preferred to any other. This implies that in a situation where less than three types of critical loads are exceeded leaves it is left up to experts to weigh up whether, or to what extent the area should be considered at risk. In this report, such areas at risk are distinguished geographically by whether none, one or two critical loads are exceeded.

Task 19.5 Workshop

The 25th CCE workshop (Zagreb, 20-23April 2014) under the Convention on Long-range Transboundary Air Pollution was held (included in MS85). The workshop, which was held back to back with the thirty first Task Force meeting of the ICP-Modelling and Mapping of the LRTAP Convention, was attended by 52 experts from 19 countries. The workshop included:
(a) sessions on the review of the 2012-2014 call for data on “no net loss of biodiversity” and its follow-up, i.e. the development of the HSI indicator (see 2.1),
(b) a session entitled “Novel critical thresholds, status of ECLAIRE (“C5 session”) other scientific progress and effect-oriented policy support” (MS91)
(c) sessions reporting on impacts of nitrogen and ozone in the field and under laboratory conditions.

The objectives of the meetings included:

(a) To review the response to the call for data on indicators, issued in 2014 by the Coordination Centre for Effects with a deadline in March 2015, following a request of the Working Group on Effects at its thirty third session (17-19 September 2014);

(b) To hold a training session addressing (National Focal Centre-) specific issues on dynamic soil-vegetation modelling related to the requirements of the call for critical load on biodiversity data;

(c) To share national results related to field measurements, tools and modelling developed in order to assess the impacts of air pollution on ecosystems and their biodiversity in general and nitrogen and ozone in particular. A session was foreseen addressing ECLAIRE methods and results to assess effects of nitrogen and ozone and their interaction (including interaction between C4 and C5).

3. Results:

The development and testing of the HSI indicator, requires that the modelling of soil chemical processes (VSD+ model) is linked to a methodology that assesses the probability of occurrence of plant species (PROPS model) on a European scale. Typical species in habitats classified under the European Nature Information System (EUNIS) are identified and tested in the context of new indicator development. More details of the modelling background are provided under ECLAIRE C14 in general and WP15 and WP16 in particular.
Finally the HSI is derived from a relationship between the probability of occurrence and a number of abiotic variables (see D 16.4). A European database of critical loads for biodiversity was finalized and embedded in the GAINS system for the assessment of effects of ECLAIRE scenarios.

3.1. *Depositions of ECLAIRE scenarios*

Four scenarios have been developed under ECLAIRE, i.e. CLE2010, CLE2050, DECARB2050 and MCE2050 (see D20.6). The focus is on scenario specific nitrogen deposition because of its persistent risk on biodiversity.

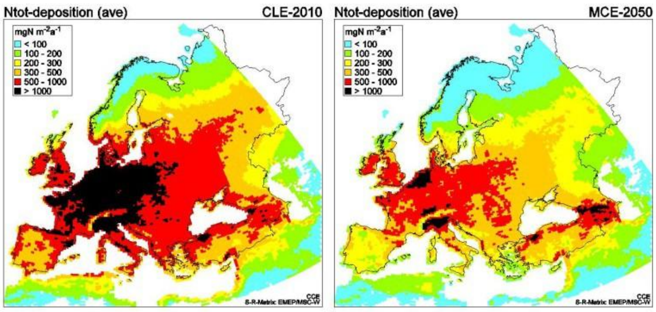

Figure 1: Deposition of total Nitrogen (mgN $m^{-2}a^{-1}$) under Current Legislation in 2010 (left) and under Maximum Control Effort in 2050

The average nitrogen deposition under CLE2010 and MCE205 (Figure 1) shows that the European area with depositions higher than 1000 mgN $m^{-2}a^{-1}$ (dark red) is broader under CLE2010 than under MCE2050. Areas with maginitudes of nitrogen deposition in ranges that are lower than 1000 mgN $m^{-2}a^{-1}$show a similar reduction between the two scenarios.
The question is whether this reduction also leads to protection of ecosystem biodiversity, i.e. critical loads for biodiversity that are not exceeded.

3.2. *Exceedance of ECLAIRE critical loads for biodiversity*

The exceedance of critical loads for biodiversity, established under ECLAIRE, are computed in the GAINS-system to cover most of the European areas under each of the scenarios (Figure 2) with values starting in the range between 0-200 eq $ha^{-1}a^{-1}$ (purple shading).

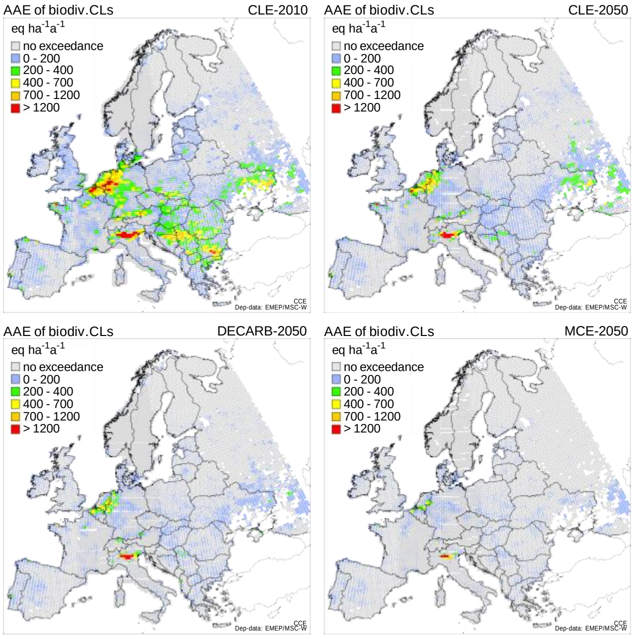

Figure 2: The Average Accumulated Exceedance (AAE) of critical loads for biodiversity under ECLAIRE scenarios CLE-2010 (top left), CLE-2050 (to right), DECARB-2050 (bottom left) and MCE-2050 (bottom-right)

Higher exceedances (200-700 eq $ha^{-1}a^{-1}$) cover large parts of Europe especially under CLE-2010 whereas relative peaks (400 - 1200 eq $ha^{-1}a^{-1}$) persist for ecosystems in The Netherlands, western part of Germany, Belgium and northern Italy both under DECARB-2050 and MCE-2050.
The location of these peaks are similar to the exceedances computed using CL_{nut} (Figure 3) and CL_{emp} (Figure 4), while illustrating also that the magnitude of exceedances of CL_{nut} and CL_{emp} is generally higher and more scattered geographically, than exceedances based on CL_{bio} (Figure 2).

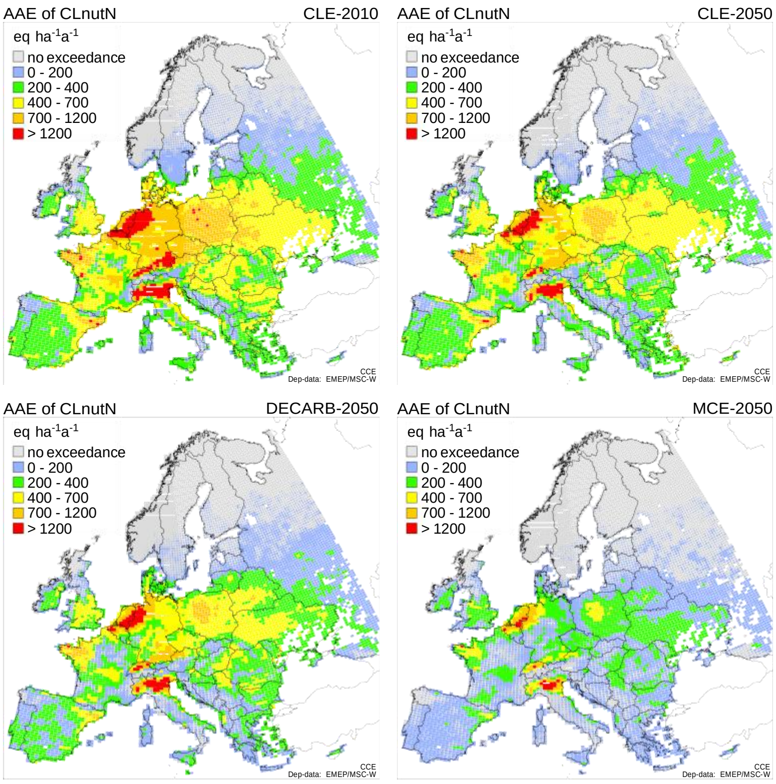

Figure 3: The Average Accumulated Exceedance (AAE) of critical loads for eutrophication under ECLAIRE scenarios CLE-2010 (top left), CLE-2050 (to right), DECARB-2050 (bottom left) and MCE-2050 (bottom-right)

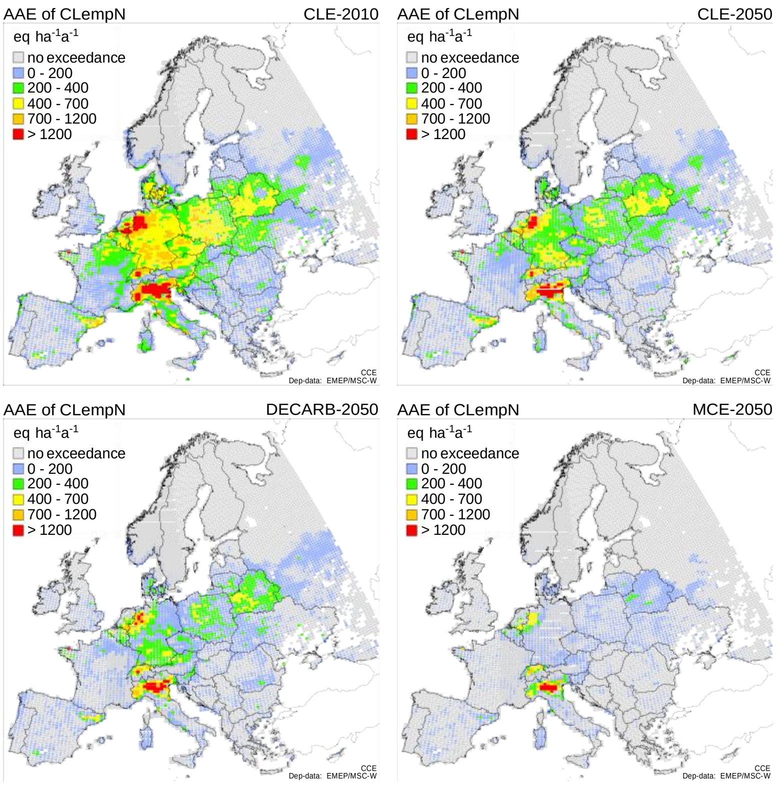

Figure 4: The Average Accumulated Exceedance (AAE) of empirical critical loads under ECLAIRE scenarios CLE-2010 (top left), CLE-2050 (to right), DECARB-2050 (bottom left) and MCE-2050 (bottom-right)

The computed European ecosystem area at risk depends on the critical load that is used. Table 1 summarizes the European ecosystem area at risk, i.e. where CL_{bio}, CL_{emp} and CL_{nut} are exceeded, as percentage of total European ecosystem area under the four ECLAIRE scenarios

Table 1: Ecosystem area (%) where CL_{bio}, CL_{emp} or CL_{nut} are exceeded under ECLAIRE scenarios CLE-2010, CLE2050, DECARB-2050 and MCE-2050

Exceedance of:	CLE-2010	CLE-2050	DECARB-2050	MCE-2050
CL_{bio}	39	37	36	35
CL_{emp}	30	25	20	8
CL_{nut}	64	59	54	41

The largest area at risk of impacts caused by nitrogen deposition is computed when CL_{nut} is used (64% under CLE2010 and 41% under MCE-2050) followed by the area at risk of exceeding CL_{bio} (39% under CLE-2010 and 35% under MCE-2050) and CL_{emp} (30% under CLE-2010 and 8% under MCE-2050).

The variability of the area at risk depending on the critical load used, raises a question on the uncertainties involved (i.e. which critical load exceedance to believe), or more specifically on (the reliability of) the location of those areas where exceedances may occur. The robustness of assessments, addressed in the next section, of the location and occurrence of exceedance is of policy relevance, and therefore relevant in the ECLAIRE context.

3.2. Robustness analysis of exceedances of ECLAIRE scenarios on a regional scale

Following the approach described under Task 19.4 it can be concluded that the likelihood of exceedances under CLE2010 varies between “likely” (yellow shading) and “virtually certain” (red shading) in broad areas in central-western Europe (Figure 5). Note that areas where one (dark green shading) or two (light green shading) critical loads are exceeded are mostly computed to be in eastern Europe. That is because CL_{nut} is mostly exceeded in that part of Europe (see Figure 3), while exceedances of CL_{bio} (Figure 2) and CL_{emp} (Figure 4) are scattered over eastern Europe. Areas where none of the critical loads are exceeded are predominantly found in northern Europe (Figure 5).

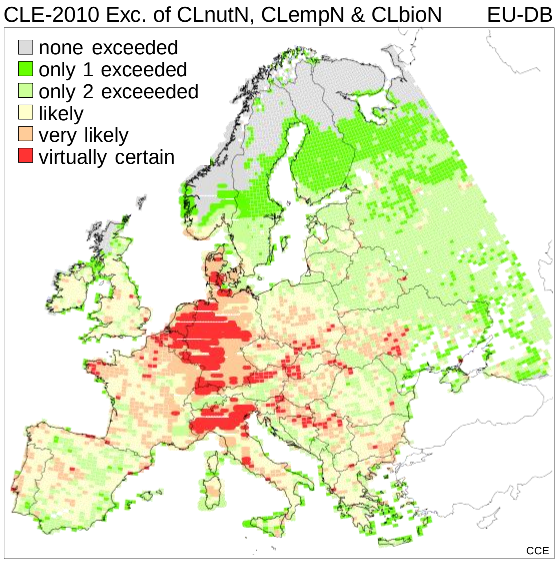

Figure 5: The likelihood that the Average Accumulated Exceedance under CLE2010 of an EMEP grid cell exceeds zero, i.e. that it contains at least one ecosystem of which CL_{bio}, CL_{emp} or CL_{nut} is exceeded

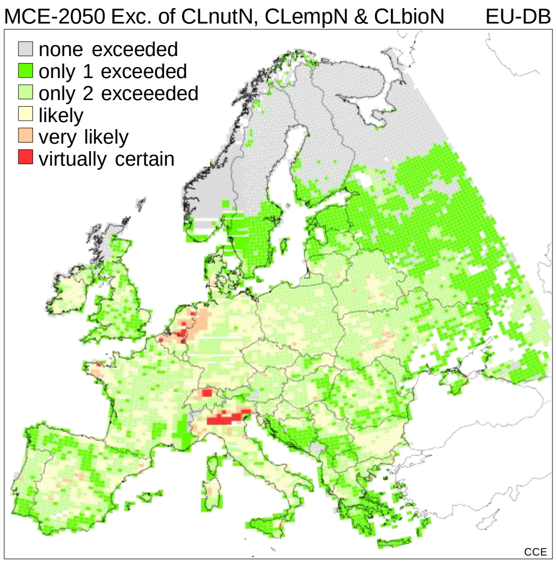

Figure 6: The likelihood that the Average Accumulated Exceedance under MCE2050 of an EMEP grid cell exceeds zero, i.e. that it contains at least one ecosystem of which CL_{bio}, CL_{emp} or CL_{nut} is exceeded

Under ECLAIRE scenario MCE-2050, a different picture emerges as exceedances turn out to be “likely”(yellow) in most of Europe, while a broad area (light green) is at risk by exceedances of only 2 out of 3 critical loads (Figure 6)

4. Milestones and Deliverables achieved:

CCE workshops including their reporting were successfully held in Copenhagen (8-11 April 2013; MS88), Rome (7-10 April 2014; MS89) and Zagreb (20-23 April 2015; MS85). Results and minutes of these meetings were presented at the 32nd session of the Working Group on Effects (WGE; Geneva, 12-13 September 2013; MS83), the 33rd session of the WGE (Geneva, 17-19 September 2014; MS84) and the 34th session of the WGE respectively (Geneva, 14-18 September 2015). MS90 (Modelling Framework in place) was completed in collaboration with C4 and presented at various meetings under the Convention on LRTAP (see above). It included the design and use of a novel threshold (Dose-Response relationship) in the GAINS system. MS92, the first complete set of scenario specific adverse effects has been completed and illustrations were presented in C5 and C4-C5 cross component meetings at the General ECLAIRE Assembly (Budapest, 29 September – 2 October 2014). A core set of scenarios for use under ECLAIRE in 2015 is being finalized under WP20 for use under C5 and C4. The modelling system (D19.2) was applied in support of a technical EEA report, submitted in September 2013 to the EEA, which finally appeared as EEA Technical Report 11/2014 (http://www.eea.europa.eu/publications/effects-of-air-pollution-on).

Deliverable D19.3 (Report on the magnitude, location and robustness) was presented in the C5 component meeting of the General ECLAIRE Assembly (Budapest, 29 September – 2 October 2014). Deliverable 19.4 (this report) and results of the C5 workshop (WS93; Laxenburg, 29-30 June 2015) will be presented at the ECLAIRE Assembly of September 2015.

5. Deviations and reasons:

Deliverable D19.4 was foreseen and achieved in May, but its reporting was delayed until it was discussed at the C5 workshop held at IIASA (Laxenburg, 29-30 June 2015).

6. Publications cited

Bobbink, R., & Hettelingh, J.-P. (2011). *Review and revision of empirical critical loads and doseresponse relationships: Proceedings of an expert workshop, Noordwijkerhout, 23–25 June 2010*. (Report 680359002/2011). Bilthoven: Coordination Centre for Effects, National Institute for Public Health and the Environment.

Bobbink, R., H. Tomassen, M. Weijters, L. van den Berg, J. Strengbom, S. Braun, A. Nordin, K. Schütz and J-P. Hettelingh, 2015. Effects and empirical critical loads of nitrogen for Europe. In W. de Vries, J-P. Hettelingh & M. Posch (eds) Critical Loads and Dynamic Risk Assessments: Nitrogen, Acidity and Metals in Terrestrial and Aquatic Ecosystems. Springer, Dordrecht, Netherlands: 85-127.

Davies, C. E., & Moss, D., 1999. *EUNIS habitat classification*. Copenhagen: European Environment Agency

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Hettelingh, J-P., M. Posch, J. Slootweg, G.J. Reinds, W. de Vries, A.-C. Le Gall and R. Maas, 2015a. Effects-based integrated assessment modelling for the support of European air pollution abatement policies. In W. de Vries, J-P. Hettelingh & M. Posch (eds) Critical Loads and Dynamic Risk Assessments: Nitrogen, Acidity and Metals in Terrestrial and Aquatic Ecosystems. Springer, Dordrecht, Netherlands: 613-635.

Hettelingh, J-P., C. Stevens, M. Posch, R. Bobbink and W. de Vries, 2015b. Assessing the impacts of nitrogen deposition on plant species richness in Europe. In W. de Vries, J-P. Hettelingh & M. Posch (eds) Critical Loads and Dynamic Risk Assessments: Nitrogen, Acidity and Metals in Terrestrial and Aquatic Ecosystems. Springer, Dordrecht, Netherlands: 573-586.

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Posch, M., & Reinds, G. J. , 2005. The European background database. In M. Posch, J.-P. Hettelingh,& J. Slootweg (Eds.), *European critical loads and dynamic modelling. CCE status report 2005* (pp. 33–37). Bilthoven: RIVM Report 259101016/2005, ISBN 9069601281, Coordination Centre for Effects, National Institute for Public Health and the Environment.

Slootweg, J., Posch, M., Hettelingh, J-P., 2014. Modelling and Mapping the impacts of atmospheric deposition on plant species diversity in Europe, CCE Status Report 2014, http://www.wge-cce.org/Publications/CCE_Status_Reports/Status_Report_2014

7. Meetings:

ECLAIRE results have been presented as follows, in 2013 and 2014 respectively::

2013 presentations of C5 and C4 components by the RIVM-CCE:

29th Session of the Task Force on the Modelling and Mapping of Critical Loads and Levels and Air pollution Effects, Risks and Trends under the Convention on Long-range Transboundary Air Pollution (Copenhagen, 8-11 April 2013)

EU Greenweek (Brussels, 4-8 June 2013) entitled "Air quality and ecosystems: Benefits of air pollution control for biodiversity and ecosystem services and use in integrated assessment"

JNCC conference "Nitrogen deposition and the habitat Directive Impacts & Responses: Our shared Experience (Peterborough, UK, 2-4 December 2013), entitled "Regional (Incl. Natura 2000 areas) scenario assessments of nitrogen critical load exceedances and of tentative impacts on species richness".

32nd Session of the Working Group on Effects (Geneva, 12-13 September 2013)

ECLAIRE General Assemblee (Zagreb, October 2013)

Task Force on Integrated Assessment Modelling under the Convention on Long-range Transboundary Air Pollution (Zagreb, 2013)

32nd Meeting of the Executive Body under the Convention on Long-range Transboundary Air Pollution, entitled "Guidance document on health and environmental improvements using new knowledge, methods and data"

2014 presentations

30th Session of the Task Force on the Modelling and Mapping of Critical Loads and Levels and Air pollution Effects, Risks and Trends under the Convention on Long-range Transboundary Air Pollution (Rome, 7-10 April 2014)

33rd Session of the Working Group on Effects (Geneva, 17-19 September 2014)

ECLAIRE General Assemblee, October 2014.

2015 presentations

25th workshop of the Coordination Centre for Effects and Task Force on Modelling and Mapping under the Convention on Long-range Transboundary Air Pollution (Croatia, Zagreb, 20-23 April 2015)

Alterra-RIVM Seminar "Critical Loads and Dynamic Risk Assessments for nitrogen, acidity and metal inputs and the future of effect-oriented policy support", seminar at the occasion of the publication of De Vries, Hettelingh and Posch (eds.) 2015 (ALTERRA, Wageningen, 27 May 2015).

ECLAIRE C5 Summary workshop, (IIASA, Laxenburg, 29-30 June 2015).

ECLAIRE General Assemblee, August-September 2015 (*in prep.)*

34rd Session of the Working Group on Effects (Geneva, 14-18 September 2015) (*in prep.)*

8. List of Documents/Annexes:

2013 Reports under the Convention on Long-range Transboundary Air Pollution:

Minutes of the 23rd CCE workshop and 29th Task Force on modelling and Mapping of critical loads and levels and air pollution effects risks and trends, held in Copenhagen (8-11 April 2013), http://www.wge-cce.org/dsresource?type=pdf&disposition=inline&objectid=rivmp:214391&versionid=&subobjectname=

32nd session of the Working Group on Effects (Geneva, 12-13 September 2013):

- ECE/EB.AIR/WG.1/2013/10 – Technical Report of the Coordination Centre for Effects and the Task Force on Modelling and Mapping, http://www.unece.org/fileadmin/DAM/env/documents/2013/air/wge/ECE_EB.AIR_WG.1_2013_10_ENG.pdf
- Informal document No. 4: DRAFT Guidance document VII on heath and environmental improvements using new knowledge, methods and data, Room document.
- ECE/EB.AIR/WG.1/2013/14 – CCE contribution to ICP-V (eds.): Benefits of Air Pollution Control for Biodiversity and Ecosystem Service, and related:
  - informal document 1, full report, http://www.unece.org/fileadmin/DAM/env/documents/2013/air/wge/No.1 Benefits_of_air_pollution_control_for_biodiversity_and_ecosystem_services.pdf
  - informal document 7, brochure, http://www.unece.org/fileadmin/DAM/env/documents/2013/air/wge/No.7 Benefits_of_air_pollution_control_for_biodiversity_and_ecosystem_services_-_Brochure.pdf
  - EB 32 version of the document
- ECE/EB.AIR/WG.1/2013/3 – CCE contribution to WGE-extended Bureau (eds.): 2013 joint report on activities of the International Cooperative Programs and the Joint Task Force on the health aspects of Air Pollution

32nd Session of the Executive Body (Geneva, 09-13 December 2013):
ECE/EB.AIR/WG.1/2013/8 , Guidance document VII on heath and environmental improvements using new knowledge, methods and data

2014 Reports under the Convention on Long-range Transboundary Air Pollution:

Minutes of the 24rd CCE workshop and 30th Task Force on modelling and Mapping of critical loads and levels and air pollution effects risks and trends, held in Rome (7-10 April 2014), http://www.rivm.nl/media/documenten/cce/Workshops/Rome/ICPMM_CCE_Minutes_2014-06-02.pdf

33rd session of the Working Group on Effects (Geneva, 17-19 September 2014):

- ECE/EB.AIR/WG.1/2014/10 –Technical report of the CCE and TF M&M, http://www.unece.org/fileadmin/DAM/env/documents/2014/AIR/WGE/ECE_EB.AIR_WG.1_2014_10_ENG.pdf

Slootweg J, Posch M, Hettelingh J-P, Mathijssen L. (2014), Modelling and Mapping of Atmospherically-induced plant species diversity impacts in Europe, CCE Status Report 2014 (*in prep.)*

2015 Publications and Reports

De Vries W, Hettelingh J-P, Posch M (eds), 2015. *Critical Loads and Dynamic Risk Assessments: Nitrogen, Acidity and Metals in Terrestrial and Aquatic Ecosystems.* Environmental Pollution

Series Vol. 25, Springer Science+Business Media, Dordrecht, xxviii+662 pp.; ISBN 978-94-017-9507-4; DOI: 10.1007/978-94-017-9508-1

Slootweg J, Posch M and Hettelingh J-P, 2015, CCE Status Report 2015 (*in prep.)*

Coordination Centre for Effects, 2015, Report by the Coordination Centre for Effects and the Task Force on Modelling and Mapping to the Working Group on Effects under the Convention on Long-range Transboundary Air Pollution, ECE/EB.AIR/WG.1/2014/10 *(in press)*