CEIP umweltbundesamt

Methodologies applied to the CEIP GNFR gap-filling 2019

Part II: Heavy Metals (Pb, Cd, Hg) of the year 2017

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1. Introduction

The EMEP Centre on Emission Inventories and Projections (CEIP) operates the UNECE/EMEP emission database (WebDab) which contains information on air pollutant emissions and projections from the Parties to the LRTAP Convention (UNECE 1979). Among these data sets, also emissions used in EMEP models (gap-filled emissions) and gridded emissions in Google maps are available from the CEIP website (www.ceip.at, CEIP 2019).

Data used by CEIP were reported by the Parties to the LRTAP Convention as sectoral emissions (NFR14) and National Total emissions according to the UNECE guidelines for reporting emissions and projections data under the Convention on long-range transboundary air pollution, Annex I (UNECE 2014). For the use by CEIP, the sector data were aggregated to 13 GNFR sectors. In several cases, no data were submitted by the countries, or the reporting is not complete or contains errors. Before these emission data can be used by modelers, missing or erroneous information have to be filled in. To gap-fill those missing data, CEIP typically applies different gap-filling methods. After the gap-filling, sector emissions are used for spatial emission mapping, i.e. the EMEP grid.

This documentation describes the gap-filling methods that have been used for the 2016 GNFR inventory (as reported in 2019) for lead, cadmium and mercury. It illustrates reasons of replacements of reported data, discusses problems of the procedure and gives an overview on the data availability and gap-filling of each country or area.

2. Summary of the process

The first step is to collect the official submissions by the Parties to the LRTAP Convention. All submissions received **up to 2nd May 2019** were used as a basis for the gap-filled data set. Parties report their emission inventories to the LRTAP Convention as sectoral emissions (NFR14) and National Total emissions according to the UNECE guidelines for reporting emissions and projections data under the LRTAP Convention, Annex I (UNECE 2014).

The second step is to aggregate the sector data to 13 GNFR sectors. The third step is plausibility checks of all reported data. If plausibility was not given, reported data were replaced (see section 4). The checks comprise:

- Comparison of the reported data with previously reported data, gap-filled data from 2017, and expert data from TNO (Denier van der Gon et al. 2005), the Global Mercury Assessment (UNEP 2013a, UNEP 2013b) and MSC-E (MSC-E 2013).
- Comparisons of the ratio of the reported data to population data and to GDP data with all other Parties. Especially population data, correlate highly with heavy metal emissions (CEIP 2017).
- Comparison of the reported sectoral distribution among the Parties.
- Comparison of the reported sectoral distribution with previously reported data of the respective country and with the mean sector distribution from the 2018 gap-filled data set of all countries.
- Comparison of the sum of sectors with the National Total.

The next step is the gap-filling or change of the inventory. Gap-filling or replacement of data is applied if

(1) no data are submitted by a Party,
(2) the reporting is not complete,
(3) the data are erroneous,
(4) there is no reporting obligation for a certain area and thus no reported data are available.

After that step, the inventory is completed and will be used for the WebDab database (data as used in EMEP models) and for spatial emission mapping, i.e. the EMEP grid.

3. Gap-filling methods

3.1. Gap-filling of National Total data

If no submission is made, first data of previous submissions are checked for plausibility. If previous reported data are plausible and complete, extrapolation of these data is done. This can be done either by extrapolation of sector data and the National Total is then calculated by the sum of the sectors, or by extrapolation of the National Total, and the sector data are then split up using a distribution of another year or country.

If no previous reported data are available or the data are not plausible, different estimates were made. These estimates comprise extrapolation of (previous reported or expert) data by using population or GDP data ([1]) of the respective country. Further, (inter-, extrapolation or copy from previous years of) expert data were used.

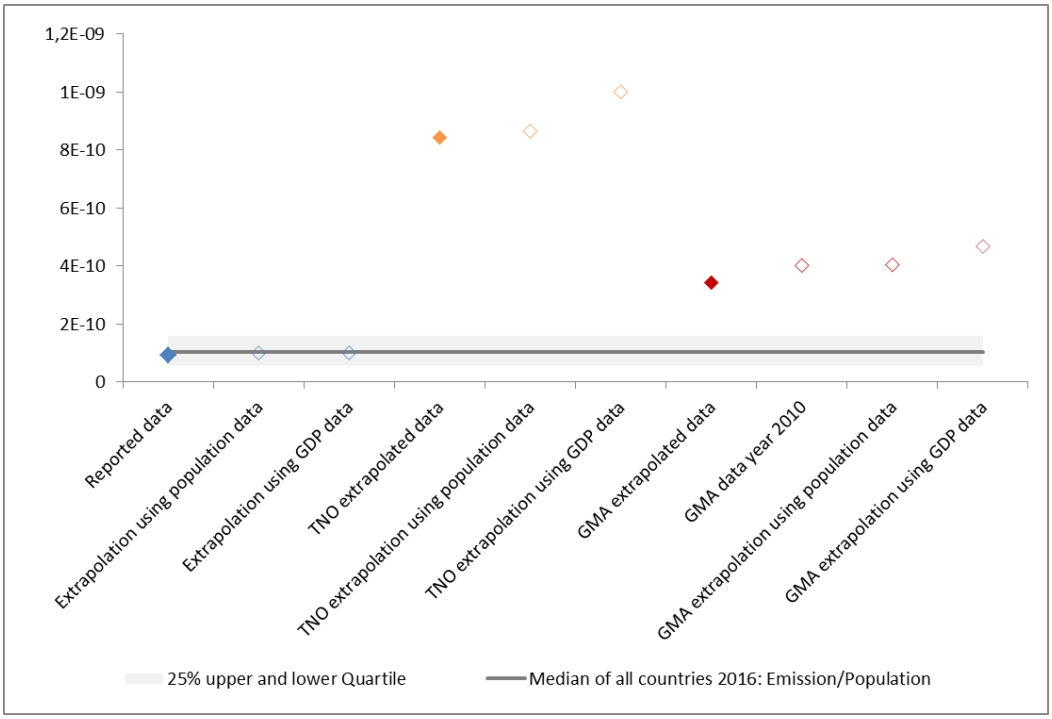
Available data for comparison are:

- The most important sources of expert estimates were data from the dutch institute TNO (Denier van der Gon et al. 2005). The study was published in 2005 and comprises emission data of lead, cadmium and mercury for the year 2000 and projections for lead, cadmium and mercury for the year 2010 and for lead for the year 2020.
- Another source of emission data were estimates from the Global Mercury Assessment (UNEP 2013a, UNEP 2013b). Estimates were made for mercury emissions of the year 2010.
- Additionally, expert estimates were provided by MSC-E (MSC-E 2013). These estimates comprise data of the year 2011 for Kyrgyzstan, Kazakhstan, Tajikistan, Turkmenistan, Uzbekistan, as well as for the Asian Areas and North Africa.

In several cases, not only one estimate is given for a country. To facilitate the choice of the estimate for the gap-filling, ratios for each pollutant between emissions and population data and GDP were calculated by using data of the gap-filled inventory from 2018 (separate for EMEP West and EMEP East countries, for the country grouping see Table 8.1) for the year 2016. The distance of the different estimates to this ratio shows how similar the estimates are to the mean. An example for mercury estimates of the FYR Macedonia (MK) is shown in Figure 3.1.

([1]) Population data from database: Population estimates and projections (Last Updated: 04/10/2019). Indicator: Population, total. Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates.
GDP data from database: World Development Indicators (Last Updated: 04/10/2019). Indicator: GDP, PPP (constant 2011 international $).

Figure 3.1 Example for different mercury estimates for the FYR Macedonia



3.2. Gap-filling of sectoral data

No expert estimates on the sectoral distribution of the emissions are available for heavy metals. The only sector distributions that can be used for gap-filling are those reported from other countries, from previous reported submissions and a mean sector distribution from the 2018 gap-filled data set of all countries.

The most common imputation method to gap-fill sector data was to use the distribution ratio of sector emissions from similar countries. To identify which countries are similar to each other, for all countries where data were available ([2]) a distance matrix using Euclidean distances was generated using GDP data ([3]) and gap-filled or reported National Total emissions from cadmium, mercury and lead as variables (z-transformed). For the Asian Areas and North Africa, this analysis was not possible. Therefore, the mean sector distribution from the 2018 gap-filled data set of all countries was used to split the sectors.

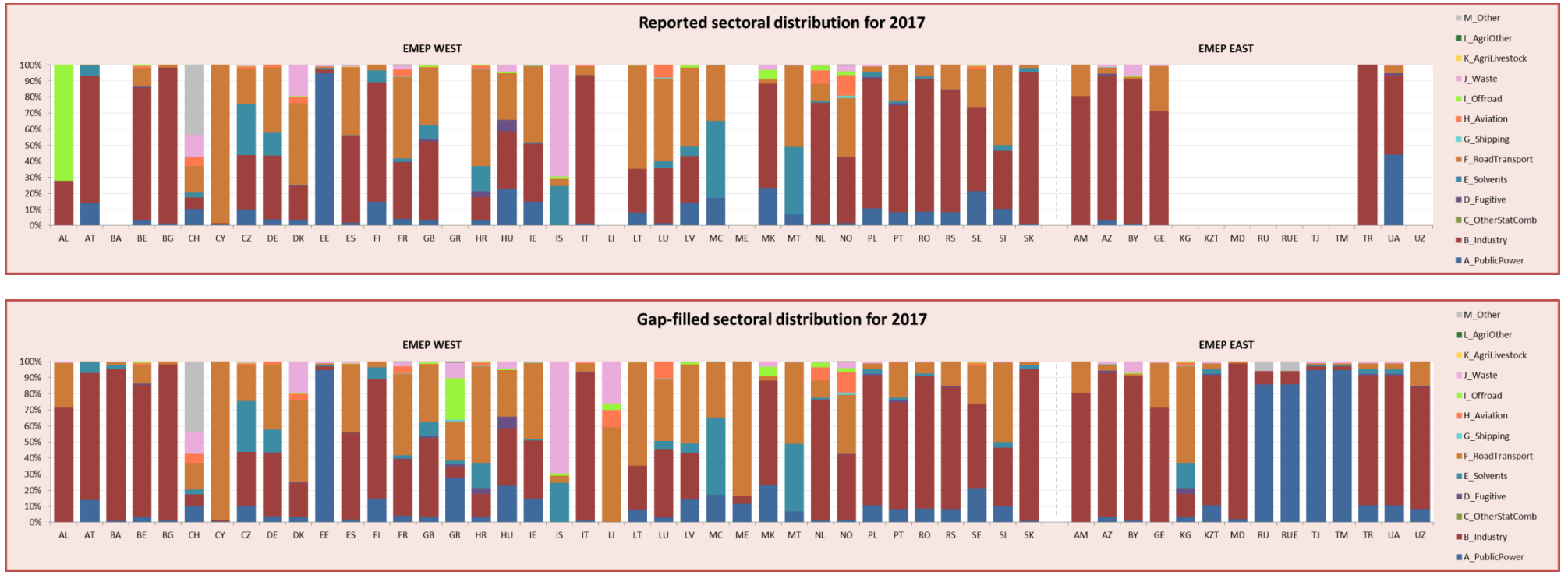
For the Russian Federation in the extended EMEP domain (RUE) a similar sector distribution as for the Russian Federation (RU) was assumed.

([2]) This means all countries addressed in this report except AST (Asian Areas), LI (Liechtenstein), MC (Monaco), NOA (North Africa), RUE (Russian Federation in the extended EMEP domain) and RU (Russian Federation in the former official EMEP domain).
([3]) Data from database: World Development Indicators. Indicator name: GDP, PPP (constant 2011 international $), indicator code: NY.GDP.MKTP.PP.KD. Values for 2017 are taken.

3.3. Gap-filling effects

Figure 3.2 shows the sectoral distribution as reported and after gap-filling of lead emissions in the year 2017 for all countries, as an example on the effects of the gap-filling.

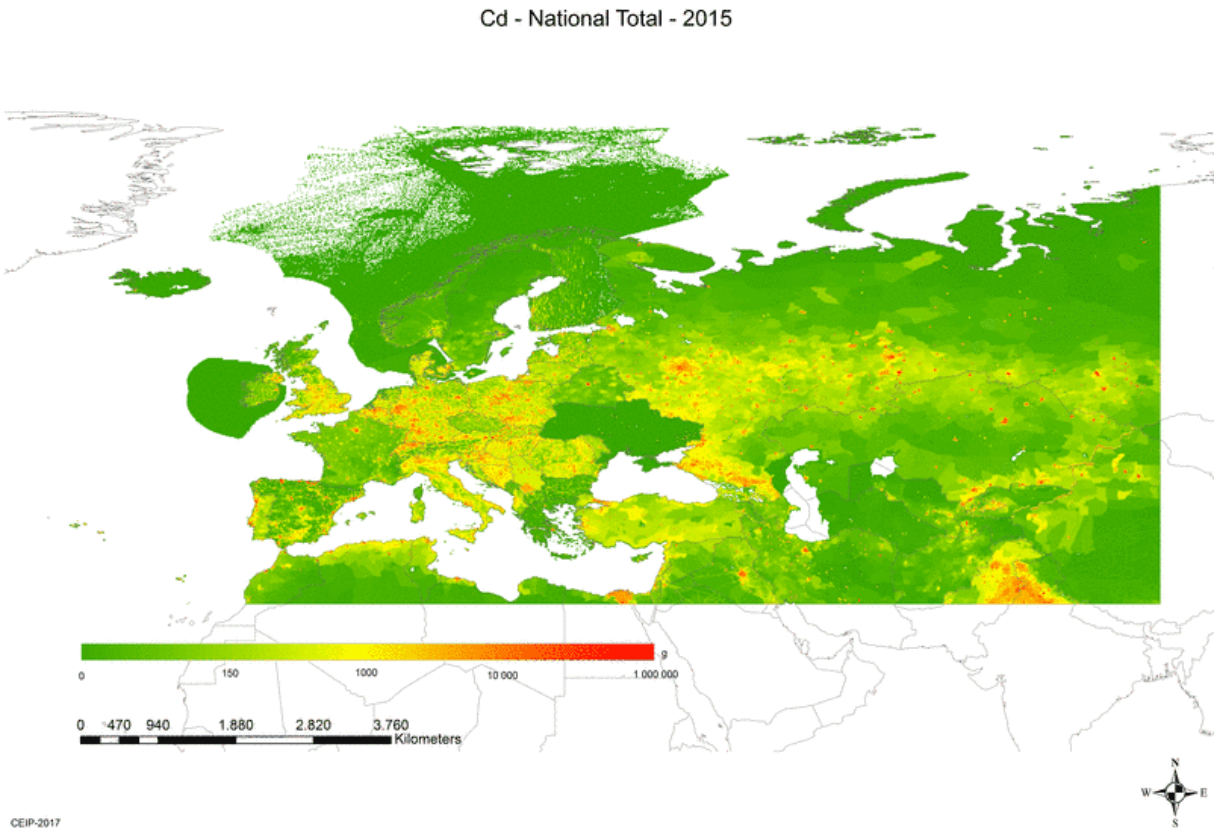
Figure 3.2 Reported and gap-filled sectoral distributions of lead emissions in the year 2017



4. Reasons for replacement of reported data

In cases, where data are in all probability erroneous, these data are replaced. If data in such cases will not be replaced, it is likely to get a wrong picture in gridded maps. As example, Figure 4.1 shows not replaced cadmium data of the Ukraine in gridded maps of the year 2015. In that case, the reported National Total was too low (compared with expert estimates and with the data of other countries), and showed an unusual sector distribution.

Figure 4.1 Example for too low National Total emissions and and unusual sector distribution of the Ukraine, showing a peculiar picture in gridded maps: Cadmium emissions of the year 2015



In 2019, data of three countries were replaced. Table 4.1 provides an overview of all replaced data of the gap-filled inventory 2019, including a short rationale. For more information see section 6, information of the respective country.

Table 4.1 Overview of and reasons for replaced data

Country	Pollutant	NT, Sectors,…	Reason
AL	Cd, Hg, Pb	Sector B + I	Incomplete sector reporting. Only sectors B and I reported; national totals and the other sectors were not reported.
AM	Cd, Hg	National Total & Sectors A, B, C	Strong discrepancy between reported 2017 national totals and expert estimates/previously reported national totals, incomplete sector reporting.

AM	Hg	Sector E	Incomplete sector reporting.
TR	Cd, Hg, Pb	National Total & Sectors B, G, I	Strong discrepancy between reported 2017 national totals and expert estimates; incomplete sector reporting.
UA	Cd, Hg	National Total & Sectors	Strong discrepancy between reported 2017 national totals and expert estimates
UA	Pb	Sectors	Strong discrepancy between reported 2017 sector distribution and expert estimates

5. Improvements of the gap-filling procedure

Most of the EMEP countries (37 of 51 countries) submitted data that seem to be complete and plausible. Problems occur especially where no data at all are available or when submitted data are not plausible.

In autumn 2017, a new tool was developed that simplify comparisons of emission data with other countries, expert data and previously reported and gap-filled data. Comparisons comprise National Totals, sector data, and data in relation to population and GDP data. This new tool was used for the gap-filling 2018, and was further improved and used for the gap-filling 2019.

In January 2019, all countries (24 countries) where data were replaced during the gap-filling 2018 or where conspicuous data were submitted, have been contacted and asked for reasons and explanations. Data of three countries (Georgia, the Ukraine, Russian Federation) were examined in more detail. CEIP got answers from 13 countries.

6. Data availability and gap-filling method per country or area

6.1. Albania (AL)

In 2019, Albania provided emissions data for heavy metals, but only for selected sectors. A complete emissions time series for the GNFR sector B-Industry was reported; however, emissions time series for other reported sectors (e.g. "F-RoadTransport", "I-Offroad") did not span all years between 1990 and 2017. For 2017, emissions of heavy metals were reported only for the sectors "B-Industry" and "I-Offroad". Furthermore, no National Totals were reported for the year 2017.

The best method to calculate 2017 National Total data was extrapolation of the 2000-2010 TNO emissions trends for cadmium and mercury. For lead, the 2017 National Total was calculated by interpolation between the 2010 TNO emissions estimate and the 2020 TNO emissions projection.

To split the National Total emissions data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a plausible sector distribution, was Georgia. Therefore the GNFR sector distribution from Georgia was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

6.2. Armenia (AM)

In 2019, Armenia provided emission data for heavy metals; however, for the year 2017 only the lead emissions inventory appeared complete. For cadmium and mercury, the reported 2017 national

totals deviated significantly from extrapolated expert estimates and from previously reported data. Furthermore, the sum of the sector emissions for cadmium and mercury were not equal to the respective National Totals and the relative sector distributions for the two pollutants differed substantially from corresponding mean sector distributions from the 2018 gap-filled data set of 2016 emissions of all countries. Thus, while the reported lead emissions were retained, reported data for cadmium and mercury were omitted and replaced.

The best method to calculate the 2017 National Total for cadmium was to extrapolate using 2017 population data multiplied by 2007 reported emissions per capita. For mercury, a linear extrapolation of the 2007-2014 trend in reported emissions data was used to estimate the 2017 National Total.

To split the National Total emissions data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a plausible sector distribution, was Georgia. Therefore the GNFR sector distribution from Georgia was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

6.3. Asian Areas (AST)

As this area consists of several countries and parts of countries, no reported data are available. Emissions of heavy metals for this area have been estimated by MSC-E in 2013 for the year 2011. National Total emissions for 2017 for all three heavy metals were copied from the MSC-E estimations for the year 2011.

To calculate the sector distribution for the Asian Areas, the mean sector distribution from the 2018 gap-filled data set of all countries was used to split the sectors.

6.4. Austria (AT)

The heavy metal emissions data of Austria reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.5. Azerbaijan (AZ)

The heavy metal emissions data of Azerbaijan reported in 2018 seemed to be complete and plausible. Therefore no gap-filling was performed. Emission data are rather low compared with extrapolated expert estimates, in particular the reported lead emissions. Further review is recommended here.

6.6. Bosnia and Herzegovina (BA)

No reported data were available for Bosnia and Herzegovina. The best method to calculate 2017 National Totals for lead, cadmium and mercury was t to extrapolate by multiplying respective 2010 per capita emissions (TNO emissions data) by 2017 population estimates.

To split the National Total emissions data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a plausible sector distribution, was Slovakia. Therefore the GNFR sector distribution from Slovakia was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

6.7. Belgium (BE)

The heavy metal emissions data of Belgium reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.8. Bulgaria (BG)

Bulgaria submitted heavy metal emissions data for the year 2017. No gap-filling was performed as National Totals seemed plausible and the inventories appeared complete in terms of GNFR sectors reported. Nonetheless, the extent to which the sector distributions of lead and cadmium were dominated sector "B – Industry" appears unusual. Bulgaria explained, that the Sector "*1A2b Stationary combustion in manufacturing industries and construction: Non-ferrous metals"* includes both combustion and industrial process emissions, not only combustion emissions. For this reason, the most of the emissions from sector *2C Metal industry* were reported in this sector, including lead emissions.

6.9. Belarus (BY)

Belarus submitted heavy metal emissions data for the year 2017. No gap-filling was performed as the inventories appear complete. Emission data are rather low compared with extrapolated expert estimates, in particular the reported lead emissions. Further review is recommended here.

6.10. Switzerland (CH)

The heavy metal emissions data of Switzerland reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.11. Cyprus (CY)

Cyprus submitted heavy metal emissions data for the year 2017. No gap-filling was performed.

It should be noted that lead and mercury emissions were dominated disproportionately by single GNFR sectors ("F – Road transport" and "B – Industry", respectively). Cyprus explained that even though the gasoline used nowadays is called unleaded a small concentration of lead exists in it. For this reason "F – Road transport" is the biggest contributor to lead emissions. Almost 38% of the total fuel used is consumed by the transport sector. Further, Cyprus explained that the mercury emissions of the sector "B – Industry" comes from the cement factory. They are calculated per ton of clinker production (EF = 0,049 g / tn of clinker produced). No other big industries exist in Cyprus.

6.12. Czechia (CZ)

The heavy metal emissions data of Czechia reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.13. Germany (DE)

The heavy metal emissions data of Germany reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.14. Denmark (DK)

The heavy metal emissions data of Denmark reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.15. Estonia (EE)

Estonia submitted heavy metal emissions data for the year 2017. No gap-filling was performed as the heavy metal inventories appear complete.

It should be noted however that emissions are generally rather high compared against extrapolated expert estimates or when compared as per capita emissions against the other EMEP countries. Compared against the other EMEP countries, the emissions of these three heavy metals are disproportionately dominated by the GNFR "A – Public electricity and heat production".

Estonia explained that the main sources of Pb and Hg emissions are power plants which operates with oil shale. The oil shale is main fuel in energy balance of Estonia and emission factors for Pb and Hg are higher than for other fuels. Currently, calculations of emissions of heavy metals are carried out on the basis of the old national methodology and the amount of fuel burned, not on the base of measurements as for example SO_2, NO_x, TSP. The uncertainty of HM emission factors is very high, as the methodology is outdated and therefore is in the process of being updated.

6.16. Spain (ES)

The heavy metal emissions data of Spain reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.17. Finland (FI)

The heavy metal emissions data of Finland reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.18. France (FR)

The heavy metal emissions data of France reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.19. The United Kingdom (GB)

The heavy metal emissions data of the United Kingdom reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.20. Georgia (GE)

Georgia submitted heavy metal emissions data for the year 2017. No gap-filling was performed. Emissions of mercury and especially lead are lower somewhat lower than extrapolated expert estimates, perhaps due to the absence of data from the potentially significant sector "C – OtherStationaryComb". Further review is recommended here.

6.21. Greece (GR)

In 2019, no submission was made by Greece. Reported data from the previous year nonetheless document the emissions up to the year 2016. These data seem to be complete and plausible. For each pollutant linear trends between the years 2001 and 2016 for each sector data were extrapolated to calculate the respective 2017 sector emissions. The National Totals for lead, cadmium and mercury were then calculated by summing the respective sector emissions.

6.22. Croatia (HR)

The heavy metal emissions data of Croatia reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.23. Hungary (HU)

The heavy metal emissions data of Hungary reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.24. Ireland (IE)

The heavy metal emissions data of Ireland reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.25. Iceland (IS)

Iceland submitted heavy metal emissions data for the year 2017. No gap-filling was performed as the emissions appear plausible the inventories seem complete. The comparatively large relative contribution from the sector “J – Waste” to the emissions of all three heavy metals should be noted. Further review is recommended here.

6.26. Italy (IT)

The heavy metal emissions data of Italy reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.27. Kyrgyzstan (KG)

In 2019, no submission was made. Reported data from previous years are available for the years 1999 (only lead), 2010-2012 and 2014-2016. However, given the limited number of GNFR sectors reported, the emissions inventories for these reported years appear incomplete. Indeed the national total emissions of the three heavy metals for the reported years are generally all substantially lower than corresponding extrapolations/interpolations of expert estimates. Data from the previous years were thus considered unsuitable for gap-filling the year 2017.

The best method to gap-fill 2017 National Total data of lead was to interpolate between the 2010 TNO emission estimate and 2020 TNO emission projection. For mercury and cadmium, extrapolation of the linear trends between 2000 and 2010 TNO estimated was performed.

To split the National Total emissions data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a plausible sector distribution, was Croatia. Therefore the GNFR sector distribution from Croatia was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

6.28. Kazakhstan (KZT)

In 2019, no submission was made by Kazakhstan. Reported data from previous years are available for the years up to 2016. However, it was noted in the previous CEIP report on *Methodologies applied to the CEIP GNFR gap-filling 2018* (CEIP 2018) that emissions estimates are only made for a few sectors and that the sum of the sectors for mercury did not equal the respective National Total. These reported data moreover are generally substantially lower than corresponding expert estimates. Thus, these previously reported data were considered as unsuitable for filling the 2017 gaps.

Cadmium and lead emissions for 2017 were filled by inserting respective 2011 MSC-E emissions estimates. For 2017 mercury emissions, GMA estimates for the year 2010 were inserted.

To split the National Total emission data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a plausible sector distribution, was Poland. Therefore the GNFR sector distribution from Poland was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

6.29. Liechtenstein (LI)

In 2019, no submission was made by Liechtenstein. Reported data from previous years are available up to the year 2016. These data seemed to be complete and plausible. For each pollutant linear trends between the years 2001 and 2016 for each sector data were extrapolated to calculate the respective 2017 sector emissions. The National Totals for lead, cadmium and mercury were then calculated by the summing of the respective sector emissions.

6.30. Lithuania (LT)

The emissions data of Lithuania reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.31. Luxembourg (LU)

The emissions data of Luxembourg reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.32. Latvia (LV)

The emissions data of Latvia reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.33. Monaco (MC)

The emissions data of Monaco reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed. It should be noted however, that the previously reported mercury and cadmium data have been revised substantially, with mercury emissions now significantly higher-, and cadmium emissions now considerably lower than the data previously reported. Further review is recommended here.

6.34. Republic of Moldova (MD)

In 2019 (as in 2018), no submission was made by the Republic of Moldova. Reported heavy metal emissions data from previous years are available up to the year 2015. These data seem to be

complete and plausible. Therefore, sector data were extrapolated (linear trend between 2000 and 2015) for all sectors apart from the cadmium emissions for the sector “L_AgriOther”. Here the 2015 sector emission value was inserted as an extrapolation would have led to a negative cadmium emission. The National Totals for lead, cadmium and mercury were then calculated by the sum of the sectors.

6.35. Montenegro (ME)

In 2019, no submission was made by Montenegro. Reported data from previous years are available up to the year 2011. These data seemed to be complete and plausible. Therefore, sector data for cadmium and mercury were extrapolated (2000-2011 linear trends), while sector data for lead were copied from 2011, as there was a major change in emissions between 2011 and the years before. The National Totals for lead, cadmium and mercury were then calculated by the sum of the sectors.

6.36. North Macedonia (MK)

The heavy metal emissions data of North Macedonia reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.37. Malta (MT)

The heavy metal emissions data of Malta reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.38. The Netherlands (NL)

The heavy metal emissions data of the Netherlands reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.39. Norway (NO)

The heavy metal emissions data of Norway reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.40. North Africa (NOA)

As this area consists of several countries and parts of countries, no reported data are available. Emissions of heavy metals for this area have been estimated by MSC-E in 2013 for the year 2011. National Total emission data were copied from the estimations for the year 2011.

To calculate the sector distribution for North Africa, the mean sector distribution from the 2018 gap-filled data set of all countries was used to split the sectors.

6.41. Poland (PL)

The data of Poland reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed. It should be noted that compared to the previous submission, lead emissions have been substantially revised downwards. These emissions are however now closer to TNO estimates for Poland, thus indicating a previous overestimation of these emissions.

6.42. Portugal (PT)

The data of Portugal reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.43. Russian Federation in the extended EMEP domain (RUE)

National Totals of lead, cadmium and mercury emissions from the Russian Federation in the extended EMEP domain (RUE) were estimated by dividing 2017 emission data for the Russian Federation in the former official EMEP domain (RU) by the ratio 0.66 : 0.34. Dividing by this ratio, which is taken from the Global Lead Inventory, reflects the reduced territorial extent of the new EMEP domain over the Russian Federation. Note that the 2017 emission data for the Russian Federation in the former official EMEP domain (RU) had to first be gap-filled (see 6.46 below).

For the Russian Federation in the extended EMEP domain a similar sector distribution as for the Russian Federation (in the former official EMEP domain) is assumed. Therefore, the2017 sector distribution of RU (gap-filled, see 6.46 below) is used to split the National Total emissions of RUE into the GNFR sectors.

6.44. Romania (RO)

The heavy metal emissions data of Romania reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.45. Serbia (RS)

The heavy metal emissions data of Serbia reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.46. Russian Federation in the former official EMEP domain (RU)

In 2019, no submission of heavy metal emissions was made by the Russian Federation. Reported National Total data are available for 1990 to 2000, 2002 to 2006 and 2009. In the years 2002 to 2006 also data for the GNFR sector “A_PublicPower” were reported, and for 2009 several sectoral data were available. The reported National Totals for the year 2009 are much lower than the trend of the years before. Sectoral data of the GNFR sector ”A_PublicPower”, which is an important source sector for heavy metals, seems to be incomplete or too small for this year.

Sectoral data reported for 2009 were copied for the year 2017. Additional, data for the GNFR sector ‘A_PublicPower’ were extrapolated for 2016 from reported data of the years 2002 to 2006. National Total emission data for the year 2017 were then calculated by the sum of the GNFR sectors.

6.47. Sweden (SE)

The heavy metal emissions data of Sweden reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.48. Slovenia (SI)

The heavy metal emissions data of Slovenia reported for the year 2017 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.49. Slovakia (SK)

Slovakia submitted heavy metal emissions data for the year 2017. No gap-filling was performed.

The sector distribution of lead is rather unusual, with a large contribution of the sector “B - Industry”. Slovakia explained that emissions of Pb were estimated using country specific emission factors (these methodology might overestimate emissions in the last decade).

6.50. Tajikistan (TJ)

No reported heavy metal emissions data were available for Tajikistan. The best method to calculate 2017 National Total lead emissions was to copy National Total emission data from the estimations made by MSC-E for the year 2011. For mercury, an unpublished expert estimate for the year 2015 was used. Cadmium emissions are assumed to be proportional to the mercury emissions with a factor of 0.56 (information from MSC-E).

To split the National Total emissions data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a plausible sector distribution, was Estonia. Therefore the GNFR sector distribution from Estonia was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

6.51. Turkmenistan (TM)

No reported heavy metal emissions data were available for Turkmenistan. The best method to calculate 2017 National Total data was for lead to copy National Total emission data from the estimations made by MSC-E for the year 2011. For mercury, the extrapolation of two expert estimates was used. Cadmium emissions are assumed to be proportional to the mercury emissions with a factor of 0.56 (information from MSC-E).

To split the National Total emissions data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a plausible sector distribution, was Estonia. Therefore the GNFR sector distribution from Estonia was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

6.52. Turkey (TR)

Turkey reported heavy metal emissions data in 2017; however, the total emissions were substantially lower than respective expert estimates and emissions per capita/per unit GDP were furthermore much lower than the other reporting CLRTAP countries. The reported data were thus replaced.

The best method to calculate 2017 National Total cadmium emissions was to extrapolate the 2000-2010 linear trend of the TNO estimates, while for lead the 2017 emissions were calculated by interpolating between 2010 TNO estimate and the 2020 TNO projection. For mercury, estimates for the year 2010 from the GMA (UNEP 2013b) were used for the year 2017.

To split the National Total emissions data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a plausible sector distribution, was Poland. Therefore the GNFR sector distribution from Poland was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

6.53. Ukraine (UA)

In 2019, the Ukraine provided emission data for heavy metals. The reported data differ strongly to expert estimates, and to the mean sector distribution from the 2018 gap-filled data set of all countries. Reported data are similar to the data reported in 2017, and these data have been used for the gap-filled inventory in 2017 and led to some unusual pictures in gridded maps. Thus, reported data were (partly) replaced. For cadmium and mercury the extrapolation of 2000 and 2010 TNO data were used to calculate the National Totals, and for lead the reported National Total was used.

To split the National Total emission data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a proper sector distribution, was Poland. Therefore the GNFR sector distribution from Poland was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

6.54. Uzbekistan (UZ)

No reported heavy metal emissions data were available for Uzbekistan. The best method to calculate 2017 National Total data for lead, cadmium and mercury was to copy heavy metal emission estimates made by MSC-E for the year 2011.

To split the National Total emission data into GNFR sectoral emissions, the sector distribution of a similar country was used. The country that turned out as most similar (see section 3.2), and that also had a plausible sector distribution, was Serbia. Therefore the GNFR sector distribution from Serbia was used to split the National Totals of Cd, Hg and Pb into GNFR sectors.

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8. EMEP Country Codes

AL	Albania
AM	Armenia
AST	Asian areas in the extended EMEP domain
AT	Austria
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BE	Belgium
BG	Bulgaria
BY	Belarus
CA	Canada
CH	Switzerland
CY	Cyprus
CZ	Czechia
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
EU	European Union
FI	Finland
FR	France
GB	United Kingdom
GE	Georgia
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
KG	Kyrgyzstan
KZT	Kazakhstan
LI	Liechtenstein
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
ME	Montenegro
MK	North Macedonia
MT	Malta
NL	Netherlands
NO	Norway
NOA	North Africa
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
RU	Russian Federation in the former official EMEP domain
RUE	Russian Federation in the extended EMEP domain
SE	Sweden
SI	Slovenia
SK	Slovakia
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
UA	Ukraine
US	United States
UZ	Uzbekistan

Table 8.1 Countries of the EMEP West and EMEP East region

EMEP West countries	AL, AT, BA, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LI, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK
EMEP East countries (9 EECCA countries + TR)	AM, AZ, BY, GE, KG, KZT, MD, RU, TR, UA
Non-EMEP EECCA countries (CLRTAP not ratified)	TJ, TM, UZ
EMEP countries outside the EMEP domain	CA, US

Note: EECCA = Eastern Europe, Caucasus and Central Asia