# Chapter 1. Gridded Data and LPS

## 1.1. *Introduction*

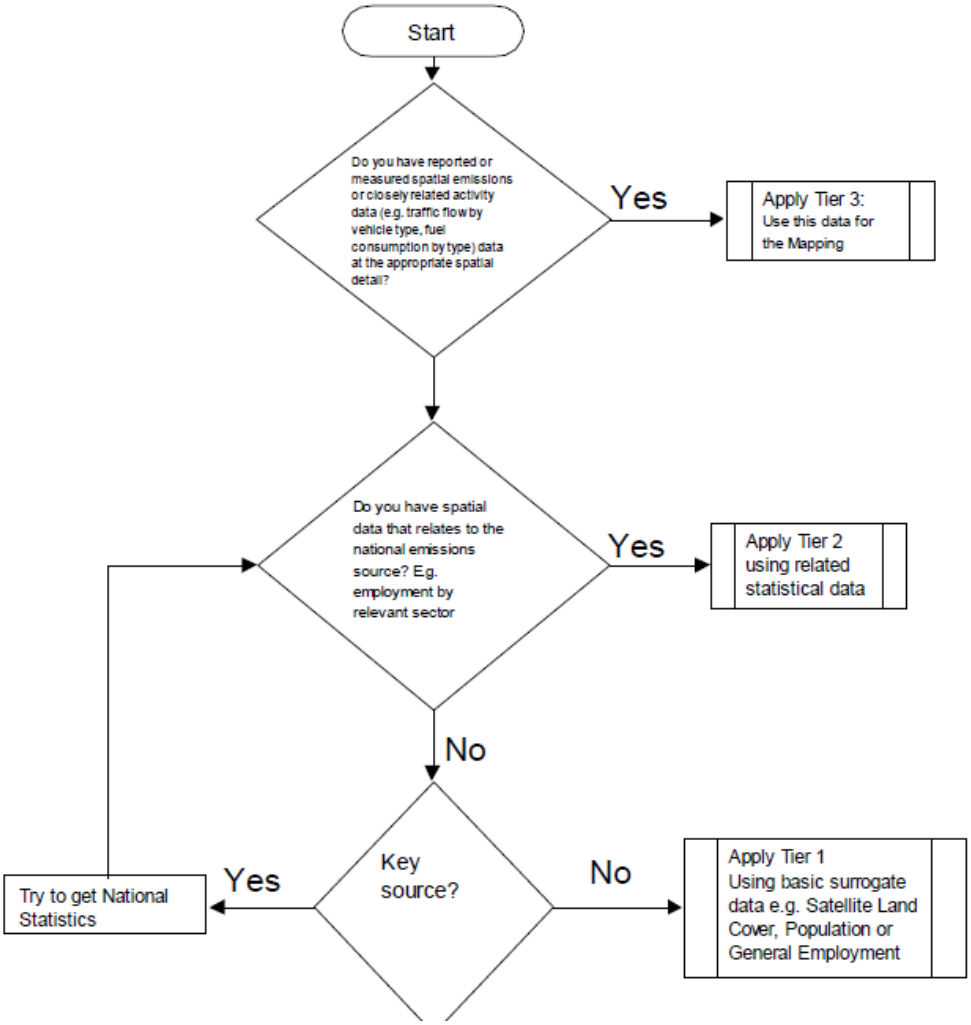
According to the Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/125) and the revised NEC Directive (2016/2284/EC), Belgium is required to report four-yearly its gridded emissions and emissions from LPS for the year x-2, starting in 2017.

By the 1st of May 2021, Belgium submitted LPS emission data of 2019 for all substances referred to in table 1 of the Guidelines taking into account the defined thresholds and being consistent with reporting under E-PRTR. Gridded emissions of 2019 were reported in the aggregated NFR sectors (GNFR) for $NO_x$, NMVOC, $SO_x$, $NH_3$, PM2.5, PM10, BC, CO, Pb, Cd, Hg, dioxins and furans, PAHs, HCB and PCBs.

According to the 36$^{th}$ EMEP Steering Body decision on gridded data, Belgium uses the new EMEP grid with a spatial resolution of 0.1º x 0.1º longitude-latitude in the geographic coordinate World Geodetic System (WGS) latest revision, WGS 84.

The methodology for spatialization of emissions is based on the guidelines provided in the EMEP/EEA Guidebook 2019. Following the decision tree from the guidebook (Figure 1-1) and analysing the available information, a tiered approach was used. This means that when point sources were known, these were chosen to map the emissions (Tier 3). In the cases where the emissions can be linked to statistical data, the emissions are spatialized using it (Tier 2). For sectors where little or no information is available for mapping, more general information is used for the spatialization such as population or surface (Tier 1).

**Figure 3-2 General decision tree for diffuse emissions mapping**




Source: EMEP/EEA Guidebook 2019. Part A Chapter 7.Spatial mapping of emissions

Figure 1-1 Decision tree for choosing tiered approach

In addition to this analysis, the three Belgian regions try as much as possible to harmonize the methodologies for the common sectors. Where available, point sources are privileged.

The GNFR sectors accounting for the national totals are summarized in Figure 1-2.

In addition, gridded emissions for the memo-items N_Natural and P_IntShipping were reported.

| | Sectors for reporting of gridded data | SNAP | Comments |
|---|---|---|---|
| 1 | A_PublicPower | 1 | Public power plants |
| 2 | B_Industry | 1+3+4+5+6 | Industrial combustion and industrial process |
| 3 | C_OtherStationaryComb | 2 | Small combustion |
| 4 | D_Fugitive | 4+5+9 | |
| 5 | E_Solvents | 6 | |
| 6 | F_RoadTransport | 7 | |
| 7 | G_Shipping | 8 | |
| 8 | H_Aviation | 8 | Only LTO |
| 9 | I_Offroad | 8 | Including rail |
| 10 | J_Waste | 9 | Including waste water and waste incineration |
| 11 | K_AgriLivestock | 10 | |
| 12 | L_AgriOther | 10 | |
| 13 | M_Other | 5 | |

Figure 1-2. GNFR sectors to be reported in 2021

Next sections describe each GNFR sector, the methodologies applied for the spatialization and some examples of the results for the national totals.

## 1.2. *Mapping Methodologies*

### 1.2.1. GNFR A : Public power

This sector considers only the public electricity and heat production activities. Methods for gridding the emissions per region are summarized in Table 1-1.

Table 1-1. NFR Tier method and surrogates used for gridding of emissions in GNFR sector A_PublicPower

| GNFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|
| | | Flanders | Brussels | Wallonia |
| A_PublicPower | Tier 3 | Point Sources | | |
| | Tier 2 | - | Installed power of CHP in each municipality | - |

In Brussels Capital Region, the spatial distribution of the emissions is based on the one hand at the exact locations at the municipal level of the municipal waste incinerator and turbojets, on the other hand the emissions of CHP are split proportionally to the installed power in each municipality.

In Wallonia, the spatial distribution of the emissions is based on the location of point sources, for both E-PRTR plants and other plants (CHP). For the E-PRTR plants, detailed emissions are available by plant and for the other plants (CHP), energy data are available and the emissions are calculated by using emission factors.

In Flanders, all emissions of the power plants, the municipal waste incinerators with energy recovery and the industrial CHP installations are allocated as a point source. The CHP installations of the tertiary and the agricultural sector are geocoded on the address.

### 1.2.2. GNFR B : Industry

Sector GNFR B considers the combustion activities of the industrial sectors in NFR sector 1A as well as the process activities of NFR sector 2A to 2L excluding the solvents use. Methods for gridding emissions per region are summarized in Table 1-2.

Table 1-2. Tier method and surrogates used for gridding of emissions in GNFR sector B_Industry

| GNFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|
| | | **Flanders** | **Brussels** | **Wallonia** |
| **B_Industry** | Tier 3 | Point Sources | | |
| | Tier 2 | Number of jobs in the particular sector | - | Municipality energy balances/Industrial zones |
| | Tier 1 | Land use/surface of industrial zones. Emissions are distributed proportionally to a specific industrial zone (chemical, iron and steel, …) via the ratio of that industrial zone over the total industrial area in Flanders. | surface area of industrial zones | Sectorial land use (2H2, 2A5b, 2A5c) |

The emissions in Brussels Capital region are gridded using the information concerning the industrial area per municipality. Most of industrial activity in Brussels is small sized, thus the emissions are split proportionally to this area.

In Wallonia, the emissions are gridded by using the energy balances by municipality. For each municipality, detailed emissions and energy consumptions from the E-PRTR point sources are known and also for ETS plants, the locations and the energy consumption is known, as well as the location and the emissions for beer production plants. The aggregated site specific energy consumption is subtracted from the energy balance of the municipality and the residual energy consumption is used to calculate the emissions. These collective emissions are mapped by using industrial economic zone as surrogate. The emissions from the production of bread (2H2), from construction and demolition (2A5b) and storage of mineral products (2A5c) are mapped by using the part of the Sector Plan concerning the habitat zone and the economic zones.

In Flanders, emission calculation and distribution methodologies differ by pollutant. All emissions (except NMVOC, POPs, particulate matter and heavy metals) of the facilities that are obliged to report their emissions according to a threshold (see IIR Chapter 1) are allocated as a point source. The emissions that are estimated in a collective way (below the threshold, see IIR Chapter 1) encompass emissions of several sectors (1A2a, 1A2b, 1A2c, 1A2d, 1A2e, 1A2f and 1A2gviii) and these are all spatialized based upon a Tier 1 approach: emission distribution per industrial zone relative to the total industrial zone area in Flanders.
Emissions of NMVOC and POPs are allocated by the EISSA tool (Emission Inventory Support System Air, Sleeuwaert et al., 2012), either as point sources or by a spatial pattern.

NMVOC emissions are mapped as point sources (1A1b, 1A2a,1A2b, 2A3, 2C1, 2C7c, 2D3b) or by the number of jobs in the particular subsector (1A2gviii, 1A2c, 1A2d, 1A2f, 1A2e, 2H2). POP emissions are also mapped as point source if available or else spatialized based upon proxy (number of employees in relevant subsector). Emissions of particulate matter and heavy metals are allocated as a point source (facilities with emissions above the threshold) or by a spatial pattern per sector (industrial zones, pattern of chemical facilities, pattern of iron and steel sector, …).The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

BE-GRID-GEN-2020-0002: *The TERT notes with reference the reported emissions of gridded and LPS data that there are a number of grid cells where the LPS and gridded data are inconsistent. The TERT has compared the gridded emissions for each grid cell with the LPS emissions (allocated to the corresponding grid cell of the 0.1°x0.1° grid). In this comparison, the TERT has identified multiple occasions where LPS emissions in a certain grid cell exceed the gridded emissions total in that same grid cell.[…].*

In response to this question of the TERT, we have made a significant improvement for the gridded data in Flanders. In the previous reporting, emissions were first allocated to the 1x1 km² grid cells and then converted to the EMEP grid. This resulted in location errors for point sources. Since this submission, the point sources were exactly assigned to the EMEP grid without intermediate step. In the LPS reporting we re-evaluated the GNFR codes. These two corrections result in an alignment between the gridded data and LPS reporting for A_PublicPower, B_Industry, E_Solvents, D_Fugitive and J_Waste.

Nevertheless, several cases remain where LPS emissions in a certain grid cell exceed the gridded emissions total in that same grid cell. This is caused by the fact that the gridded data are based on point source locations (of the emission points) whereas the LPS reporting is based on facility level in the EU registry. That is why in several cases the emissions are assigned to a neighbor grid cell.

In the Walloon region, the geographical coordinates are now the same for the LPS, the gridded data and the E PRTR registry.

### 1.2.3. GNFR C: Other stationary combustion

The sector GNFR C includes the emissions from the combustion in the commercial, the residential and agriculture sectors. The methods for gridding emissions per region are summarised in Table 1-3.

Table 1-3. Tier method and surrogates used for gridding of emissions in GNFR sector C Other stationary combustion

| GNFR | NFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|---|
| | | | **Flanders** | **Brussels** | **Wallonia** |
| **C_OtherStationaryComb** | 1A4ai | Tier 2 | energy balance per municipality (or the Flemish energy balance in the case of coal, waste, lamp petroleum, biogas and sludge disaggregated according to the "Floor area" | Office surfaces | energy balance of each municipality distributed on commercial and institutional surface by municipality |

| | | | | | |
|---|---|---|---|---|---|
| | | | combined with land use. | | |
| **C_OtherStationaryComb** | 1A4bi | Tier 2 | Energy consumption per municipality disaggregated according to "Residential Floor Area"; the residential floor area map. Since the fuel types used vary greatly according to the character of the region (rural versus urban), 3 variants of the map were derived. | Population data | Energy balance of each municipality distributedon residential building area |
| **C_OtherStationaryComb** | 1A4ci | Tier 2 | A part of the emissions are distributed based on landuse/landcover data (sub-sector dependent). Another part of the emissions originates form point sources (XY) | - | Emissions are distributed on the basis of the agricultural plot distribution. |

In Brussels Capital Region, there are emissions for sectors 1A4ai and 1A4bi. The distribution of emissions for the commercial sector is based on the office surfaces per municipality since service sector represents the main activity of the tertiary sector in the region. Regarding the residential sector, the distribution is based on the population data.

In Wallonia, the emissions are gridded by using the energy balances by municipality. The distribution of emissions is made on the E-PRTR plants locations and on the commercial and institutional surface by municipality (1A4ai), on the basis of the residential buildings locations (1A4bi) and on the basis of the agricultural plots (1A4ci) (1).

In Flanders, the emissions of the commercial/institutional sector (1A4ai), the residential sector (1A4bi) and the agricultural sector (1A4ci) are gridded by the EISSA-B tool.

EISSA-B was developed in 2017 and within this project an update and expansion of the emission inventory due to building heating in the residential, the tertiary and the agriculture and horticulture sector in Flanders was envisaged. On the one hand, the calculation of emissions needed to be performed at a Tier 2 level, implying that the emission factors should not only depend on the fuel type but also on the type and the age of the heating installations. On the other hand, the emissions of the pollutants had to be geographically allocated, both at municipality level and at km² resolution, and this in the most accurate way possible, making use of specific map layers and algorithms. Both, emission calculation and geographical allocation of the emissions was required per fuel type for the residential, the tertiary, and the agricultural and horticultural sector.

To achieve this goal, VITO developed a quantitative database and GIS based model based on EISSys, which is a software framework that, in a continuous process, is being developed within VITO's GEOFlex product line (https://geoflex-solutions.eu/) and of which the EISSA model for POPs, currently already being used by Emissie Inventaris Lucht, is also an application. The newly developed tool was

named EISSA-B. Herein, EISSA stands for ‘Emission Inventory Support System Air’, the platform in which, in the long term, the calculation, geographical allocation and analysis of *all* emissions to air ideally should be brought together. The -B stands for Buildings, as the current application is intended to calculate, allocate and analyse all emissions to air due to building heating.

The EISSA-B tool is a combination of two existing tools, namely WoET and GEOGREMIS. Indeed, in addition to calculation and allocation of emissions due to wood combustion (WoET), emissions due to building heating based on all other fuels (GEOGREMIS) can also be calculated and geographically allocated. However, EISSA-B has been optimized with respect to the existing WoET and GEOGREMIS tools: energy consumption can be imported by the user, additional fuels / pollutants can be added easily, calculations from 1990 have become possible, .... Moreover, the tool has also been updated as compared to the existing tools: the current tool for instance allows to include recent knowledge about environmental legislation, assumptions, emission factors, .... The user-friendly and transparent tool provides results in the form of tables, charts and maps, according to user settings, expectations and specifications (cf. spatial resolution, compatibility with the data warehouse being used by Emissie Inventaris Lucht, ...). Furthermore, in the long term the tool eventually can be used for scenario management.

Prior to the development of the actual tool, a thorough analysis on how to develop the methodological / scientific core for calculating emissions due to building heating was performed. This was essentially done in 4 steps. Initially, the level of detail was determined. This level of detail relates to the substances, the sectors and subsectors, the fuel types and the installation types. Then a methodology was developed to refine the Flemish energy consumption, known per fuel type from the Energy Balance, according to the specified level of detail. In other words, a methodology to assign shares of the Flemish energy consumption to the different installation types within the fleet. In order to allow calculation of emissions starting from the energy consumption, distributed over the installation fleet, in a third phase a compilation of emission factors was made. Finally, the geographical distribution of energy consumption and emissions was completely revised.

Energy consumption for Flanders is disaggregated according to energy consumption per municipality. This is done by means of an Excel tool developed by VITO at sector level in the context of the Covenant of Mayors [http://www.burgemeestersconvenant.eu]. The obtained energy consumption per municipality (or the Flemish energy consumption in the case of coal, waste, lamp petroleum, biogas and sludge; due to no match with the Covenant of Mayors) are then further disaggregated according to the "Floor area" combined with land use (1A4ai). For the residential sector (1A4bi), the residential “Floor area” is used. Since the fuel types used vary greatly according to the character of the region (rural versus urban), 3 variants of the map were derived. In the agricultural sector, a part of the emissions from other stationary combustion practices is based on landuse/landcover data. The selection of parcels based on land use/land cover is sub-sector dependent. In general, the emissions of each agricultural sub-sector are spatially distributed among these selected parcels/area with each hectare of the selected parcels being allocated the same amount of emissions. There is no distinction made between the different fuel types used. Another part of the emissions originates form point sources (XY). The spreading pattern for the point sources differs for each sub-sector and fuel type.

Within this project Flemish emissions due to building heating were calculated and geographically allocated with the EISSA-B tool. This was done for all pollutants, all sectors and all fuel types, for the time window 1990 - 2019.

The review question *BE-GRID-GEN-2020-0001* has been solved by the adjustment of the method of geographic distribution.

The locations of the emissions that are gridded by a detailed spatial pattern are converted to the EMEP grid by means of a datawarehouse.

### 1.2.4. GNFR D : Fugitive

The sector GNFR D gathers fugitive emissions from different activities involving solid, liquid and gaseous fuels. The methods for gridding the emissions per region are detailed in Table 1-4.

Table 1-4. Tier method and surrogates used for gridding of emissions in GNFR sector D Fugitive

| GNFR | NFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|---|
| | | | Flanders | Brussels | Wallonia |
| D_Fugitive | 1B2av | Tier 3 | Point Sources | - | Point Sources |
| | All, except 1B2av | Tier 2 | Number of jobs in the particular sector | - | Gas consumption by municipality and gridded on gas canalizations per municipality |
| | | Tier 1 | Population | Uniform distribution over Brussels area | - |

Brussels Capital Region reports emissions for the distribution of oil products and the transmission and distribution of natural gas. Emissions are uniformly distributed over the regional area since there is no more precise data concerning this sector.

In Wallonia, the locations of the petroleum stocks are known. The 'PICC' data (Mapping project in the Walloon region) (1) are used to localize petroleum stations. Concerning the gas transportation, the emissions are disaggregated by municipality by using gas consumption by municipality as surrogate and then mapped on the municipality with the grid of gas canalizations.

In Flanders, all emissions (except NMVOC and POPs) of the facilities that are obliged to report their emissions according to a threshold (see IIR Chapter 1) are allocated as a point source. Emissions of NMVOC and POPs are allocated by the EISSA tool, either as point sources or by a spatial pattern. NMVOC and POP emissions are mapped as point sources (1B2c, 1B2aiv), by population (1B2av) and by the number of jobs in the particular subsector (1B2b).

The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

### 1.2.5. GNFR E : Solvents

The sector GNRF E includes the use of solvent products. Methods for gridding the emissions per region are summarized in Table 1-5.

Table 1-5. Tier method and surrogates used for gridding of emissions in GNFR sector E Solvents

| GNFR | NFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|---|
| | | | Flanders | Brussels | Wallonia |
| E_Solvents | All, except 2G Lubricants (Heavy metals) | Tier 3 | Point Sources | - | Point Sources |
| | | Tier 2 | number of jobs in the particular subsector | - | - |
| | | Tier 1 | Population | Uniform distribution | Population |

| | | | | | |
|---|---|---|---|---|---|
| | | | | over Brussels area | |
| | 2G Lubricants (Heavy metals) | Tier 3 | Gridded emissions are included in GNFR F | method from GNFR F | Population |

The solvents sector includes a variety of activities. In the Brussels Capital Region, heavy metal emissions from the use of lubricants in road transportation were gridded by the same method as the road transport sector described in the section GNFR F. A simplified method has been chosen to grid emissions from the other activities, being a uniformly distribution over the regional area.

For Wallonia, the emissions coming from the yearly reporting obligation by the industrial companies via the integrated environmental report are located on the basis of the geographic coordinates of the companies. The other emissions mainly coming from domestic solvent use are gridded on the basis of the population data (2).

In Flanders, all emissions (except NMVOC and POPs) of the facilities that are obliged to report their emissions according to a threshold (see IIR Chapter 1) are allocated as a point source. Emissions of NMVOC and POPs are allocated by the EISSA tool, either as point sources or by an allocation pattern. NMVOC-emissions are mapped as point sources (part of 2D3d, 2D3g, part of 2D3h), by population (2D3a, part of 2D3d) or by number of by number of jobs in the particular sector (2D3f, part of 2D3h). POP emissions are spatialized by number of employees in this particular sector (2D3b) and by population patterns (smoking of tobacco). Emissions of particulate matter and heavy metal emissions (due to firework and smoking of tobacco) are gridded based on the population pattern.
The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

Difference between gridded data (annex v) and total of NFR table (annex I): For Flanders, the emissions of heavy metals from the use of lubricants in the road transportation are allocated under category 1A3b (GNFR F) instead of 2G (GNFR E) for the gridded data. Due to a technical difficulty, the gridded data from 2G could not be separated from the other road traffic emissions in the output of the data warehouse. We are working on a solution so that the emissions can be split up at the next submission.

### 1.2.6. GNFR F : Road transport

Road transport emissions reported under GNFR F include NFR sectors 1A3bi to 1A3bvii. Methods for gridding the emissions per region are summarized in Table 1-6.

Table 1-6. Tier method and surrogates used for gridding of emissions in GNFR sector F Road transport

| GNFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|
| | | **Flanders** | **Brussels** | **Wallonia** |
| **F_RoadTransport** | Tier 3 | road segments with share of light and heavy traffic and split by urban, rural and highway roads | Combination of road transport information (road structure, mobility data) and specific emissions factors by driving mode from COPERT (highway, rural/suburban and urban) | road segments with share of light and heavy traffic and split by urban, rural and highway roads |

The submitted gridded data are based on fuel sold.

Brussels Capital Region uses a combination of road transport information (road structure, mobility data) and specific emissions factors by driving mode from COPERT in order to generate the gridded emissions for GNFR F sector. The first step is to determine mobility data per road according to the 3 driving modes used in COPERT (highway, rural/suburban and urban) in each municipality. For each driving mode, the total emissions at the regional level are affected to a given municipality proportionally to the cumulated mobility data in the municipality compared to the whole Region. Finally, the emissions from the 3 driving modes are summed for each municipality and attributed to the road segment network.

The methodology in Wallonia is similar to the Brussels Capital Region. The emissions are first calculated by road segment of the Walloon road network. These emissions result from a combination of volume of traffic (light and heavy), length and driving mode (urban/rural/highway) of the road segments, and the associated emission factors by driving mode from COPERT. These emissions are then added together within the EMEP gridcells and rescaled to reach the total emissions from NFR-code 1A3b.

In Flanders, also the split by driving mode from COPERT is used to generate gridded data of the road transport sector. The COPERT-calculated emissionsare distributed along the road network of Flanders, for which the share of total traffic volumes is known per road segment, disaggregated for light and heavy traffic. The emissions from CAR + LDV + L-category are spread according to the share of light traffic on the road segments, whereas HDV and BUS / Coach emissions according to the share of heavy traffic. In addition, for every road segment the driving mode is known, so COPERT emissions by driving mode are attributed accordingly.

Difference between gridded data (annex V) and total of NFR table (annex I): For the assignment, split factors emissions/road segment are calculated in a data warehouse. Due to rounding off during this calculation it is possible that a slight difference occurs between the total gridded data of the road transport sector and the sum of totals of the NFR-codes 1A3b reported in annex I. For Flanders, the gridded emissions of heavy metals from the use of lubricants in the road transportation are allocated under category 1A3b instead of 2G. Due to a technical difficulty, the gridded data from 2G could not be separated from the other road traffic emissions in the output of the data warehouse. We are working on a solution so that the emissions can be split up at the next submission.

### 1.2.6. GNFR G : Shipping

The GNFR G sector includes international inland waterways and national navigation. Methods for gridding the emissions per region are summarized in Table 1-7.

Table 1-7. Tier method and surrogates used for gridding of emissions in GNFR sector G Shipping

| GNFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|
| | | Flanders | Brussels | Wallonia |
| G_Shipping | Tier 3 | Amount of tonkm per waterway, geographic dataset of ship movements on shipping routes and in harbours | - | - |
| | Tier 2 | - | Length of the canal | navigable rivers |

Brussels Capital Region only reports emissions from sector 1A3dii. Emissions are distributed according to the length of the canal among the Brussels EMEP grid cells. The canal is the only navigable waterway in the region.

In Wallonia, the emissions for inland waterway transport are allocated to the navigable rivers.

For the Flemish Region, the spatialized emissions of the sector G_Shipping are calculated via the EMMOSS model (see also § 3.4.2.4).

Emissions from inland shipping are spread over the length of the navigable waterways. Emissions from maritime shipping (shipping routes mainly in the North Sea that are not part of the EMEP grid, and ports) are distributed in proportion to a geographic dataset of ship movements.

Because a part of the emissions of the sector 1A3di(ii) falls outside the grid attributed to Belgium, a difference between the gridded data and the data reported for the NFR-code 1A3di(ii) in annex I occurs.

### 1.2.7. GNFR H : Aviation

The GNFR H sector includes emissions from LTO from aviation activities. Methods for gridding the emissions per region are summarized in Table 1-8.

Table 1-8. Tier method and surrogates used for gridding of emissions in GNFR sector H Aviation

| GNFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|
| | | Flanders | Brussels | Wallonia |
| H_Aviation | Tier 3 | flight data: EUROCONTROL DDR2 database | Not applicable | flight data: EUROCONTROL DDR2 database |

There is no aviation activity in Brussels Capital Region. Brussels International Airport is located in Flanders region.

In Wallonia, the emissions for each airport are allocated to the area of the airports on the grid (two commercial airports and six tourism airports). The LTO areas of the two commercial airports were estimated with the help of Belgocontrol. The emissions of the six airports are allocated to the EMEP cells where the tourism airports are situated.

In the Flemish Region the gridded emission data due to aviation activity are calculated with the EMMOL model. The calculation is based on EUROCONTROL/BELGOCONTROL data from airports and fuel amounts.

LTO emissions consist of different flight phases. For the emissions at the airport itself (landing + taxi in + taxi out + take off), a uniform distribution over the polygon (territory) of the airport was assumed.

For the geographic spread of the LTO sub-phases final approach and climb out, an average spread was calculated based on detailed flight data from the EUROCONTROL DDR2 database. It contains all IFR flights, with a time resolution of a few minutes. By calculating the share of each 1x1 km² grid cell for each flight, and then aggregating it over all flights, the average share of each grid cell (1x1 km²) in the emissions can be calculated.

The processing (separate for zone_approach and zone_climb_out) consists of a number of steps. The main steps are:

1. select all flight segments below 3000 feet (FL <30, the flight altitude limiting the LTO cycles)

2.select the flight segments that fall within a certain radius around the airport

3. divide all selected flight segments over the 1x1 km2 grid

4. determine the sum of the segment lengths for each grid cell; the share of the grid cell in the emissions is the division of this sum of segment lengths by the sum of all segment lengths considered.

Difference between gridded data (annex V) and total of NFR table (annex I): a very small amount of the emissions of military aviation is allocated under 1A3aii(i) (GNFR H) instead of 1A5b (GNFR I). Due to a limitation of de model used, the small amount of the emissions could not be separated.

### 1.2.8. GNFR I : Off road

Sector GNFR I includes a variety of sectors: industry, agriculture, residential, railways and pipelines transport. Methods for gridding the emissions per region are summarized in Table 1-9.

Table 1-9. Tier method and surrogates used for gridding of emissions in GNFR sector I_Offroad

| GNFR | NFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|---|
| | | | VLA | BRU | WAL |
| I_Offroad- | 1A2gvii | Tier 3 | - | - | Point Sources |
| | | Tier 2 | Pattern based on land use | - | Industrial areas by municipality |
| | | Tier 1 | - | Uniform distribution over Brussels area | - |
| | 1A3c | Tier 2 | - | - | Railway sections on which the oil-fuelled trains run |
| | | Tier 1 | Railway network | Length of railway network per municipality | - |
| | 1A3ei | Tier 3 | Point sources | - | Point Sources (gas compression plants) |
| | | Tier 1 | - | Uniform distribution over Brussels area | - |
| | 1A3eii (incl. 1A4aii) | Tier 3 | - | - | Point Sources (harbours, air ports,..) |
| | | Tier 2 | Pattern based on land use | - | - |
| | | Tier 1 | | Uniform distribution over Brussels area | - |
| | 1A4bii | Tier 2 | Pattern based on land use | - | Garden areas by municipality |
| | | Tier 1 | | Uniform distribution over Brussels area | |
| | 1A4cii | Tier 2 | Pattern based on land use | - | Agricultural plots and Sector Plan covering forests and parks |
| | | Tier 1 | | Uniform distribution over Brussels area | |
| | 1A4ciii | | Not gridded. Emissions take place in the North Sea, outside of BE | Not applicable | Not applicable |

| | | | | | |
|---|---|---|---|---|---|
| | | | EMEP grid domain | | |
| | 1A5b | Tier 3 | - | - | Military airports |
| | | Tier 2 | Pattern based on land use | - | - |

The emissions of the offroad sector in Brussels Capital Region are distributed uniformly over the Region's surface area, except for the NFR sector1A3c for which emissions are distributed using the length of the rail network per municipality.

In Wallonia, the sector 1A2gvii is distributed by using offroad emissions from industrial point sources and the industrial areas by municipality (LPS emissions subtracted). Emissions from sector 1A3c are distributed using railway sections on which the oil-fuelled trains run. The gridding of the sector 1A3ei is based on point sources emissions (gas compression plants, harbours and air ports). The sector 1A4bii is distributed using garden areas (garden areas = residential areas – residential buildings areas) and the sector 1A4cii is distributed using the data of the agricultural plot (3) and the Sector Plan covering forests and parks (4) (5). The sector 1A5b is distributed by using offroad emissions from industrial point sources.

In Flanders emissions are also gridded withdifferent spatial patterns according to the sector. The emissions are distributed using a pattern based on the land use and the degree of industrialization (1A2gvii), harbours (1A3eii), urbanization (1A4bii), agricultural area and forestry (1A4cii) and defense area (1A5b) (Decoene, 2012).
To spread the railways emissions (1A3c) the network of railway segments is used. At the borders of Flanders, the fraction of the railway segment that is situated in Flanders is calculated, and this split factor is used to calculate the fraction of the emissions that can be attributed to Flanders. Due to this methodology it is possible that a slight difference occurs between the gridded railways emission data (annex V) and the total emissions reported in the NFR-code 1A3c annex I).
Emissions reported in the sector 1A3ei are allocated to point sources.
Emissions of military aviation (also reported in 1A5b) are calculated with the EMMOL model. Emissions from Melsbroek military airport are included in the distribution pattern (civil aviation) LTO of Brussels Airport. The emissions from the other military airports are evenly spread over Flanders.
Emissions of national fishing (1A4ciii) are part of the EMMOSS model and are calculated in Flanders. Because all emissions of national fishing take part in the Channel (North Sea), and this sea falls outside the grid attributed to Belgium, the emissions of national fishing are not included in the gridded data.

Difference between gridded data (annex V) and total of NFR table (annex I): a very small amount of the emissions of military aviation is allocated under 1A3aii(i) (GNFR H) instead of 1A5b (GNFR I). Due to a limitation of de model used, the small amount of the emissions could not be separated.

The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

### 1.2.9. GNFR J : Waste

Sector GNFR J considers the NFR waste sectors. The emissions from municipal incinerators with energy recovery are included in sector GNFR A. Methods for gridding the emissions per region are summarized in Table 1-10.

Table 1-10. Tier method and surrogates used for gridding of emissions in GNFR sector J_Waste

| GNFR | NFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|---|
| | | | Flanders | Brussels | Wallonia |
| J_Waste | All, except 5D1 and 5E | Tier 3 | Point Sources | | |
| | 5D1 | Tier 2 | Number of Jobs in the particular sector | - | - |
| | | Tier 1 | Population | | |
| | 5E | Tier 3 | Point Sources (NMVOC, POP) | - | - |
| | | Tier 1 | Population | | |

Brussels Capital Region reports emissions from several activities and according to the sector a different methodology is applied. For composting, cremation and wastewater treatment, the emissions are allocated to the municipality where the installation is located. For sector 5E, corresponding to fires, the distribution of the emissions is based on the population.

In Wallonia, the spatialization of the emissions is based firstly on the location of point sources. This is the case for the E-PRTR plants, the solid waste disposal sites, the incineration and cremation facilities and the composting units. For the emissions of wastewater (5D1) and fires (5E), as it is not related to point sources, the emissions are spatialized following the Walloon municipalities population (2).

In Flanders, all emissions (except NMVOC and POPs) of the facilities that are obliged to report their emissions according to a threshold (see IIR Chapter 1) are allocated as a point source. Waste incineration facilities have energy recovery, hence the emissions are allocated in the GNFR-sector A_PublicPower. Emissions of NMVOC and POPs are allocated by the EISSA tool, either as point sources or by an allocation pattern. NMVOC-emissions are mapped as point sources (5E) and by number of jobs in the particular sector (5D1). POP emissions are also mapped as point sources (5E and 5C1bv) or by inhabitants in rural areas (5C2).
The emissions due to Open burning of waste and emissions from house and car fires are spread according to the same method that was used to spatialize the off-road emissions by households (pattern based on the land use and the degree of urbanization) (Decoene, 2012).

The emissions from the point sources and the emissions that are distributed via a detailed spatial pattern are combined and converted to the EMEP grid by means of a datawarehouse.

### 1.2.10. GNFR K : Agriculture - Livestock

Methods for gridding the emissions per region for GNFR sector K Agriculture – Livestock are summarized in Table 1-11.

Table 1-11. Tier method and surrogates used for gridding of emissions in GNFR sector K_AgriLivestock

| GNFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|
| | | Flanders | Brussels | Wallonia |
| K_AgriLivestock | Tier 3 | Point Sources (animal number and manure management system on farm level) | - | Point sources |

| | | | | |
|---|---|---|---|---|
| | Tier 2 | - | - | Agricultural plots (point sources subtracted) |
| | Tier 1 | - | Agricultural surfaces | - |

Brussels Capital Region reports emissions from agriculture livestock. Emissions are allocated according to agricultural surfaces per municipality.

In Wallonia, emissions of $NH_3$, NOx, NMVOC and PM coming from the livestock (NFR sector 3B) have been spatially distributed firstly with the location of the intensive agricultural exploitations (pigs and poultry farms) and secondly across the municipalities, thanks to national and regional statistics giving the number of heads by municipalities(6). If there are intensive farms in the municipality, the number of heads of the intensive farms are subtracted from the number of the municipality. The numbers of animals are not available for every year. So we used the latest information available (2019 for cattle, poultry, swine, 2016 for ovines, goats and horses) and these partitions were used with the 2019 regional activity data for Wallonia. Once the emissions of livestock have been calculated by municipality, the agricultural plot has been used to distribute the emissions according to the type of land used (agricultural emissions occur only on crop and pasture) (3).

In Flanders, the emissions ($NH_3$) are spread following the detailed geographic level of input data (XY-coordinate). the ammonia emissions of manure management are calculated with the EMAV2.1 model (see also IIR Chapter 5). Input data (animal number, manure management system, e.o.) is available on the level of the farm. Therefore the calculation and geographical spreading of the $NH_3$-emission can occur on this same level (XY-coordinate). The emissions of NO (reported as NOx) and NMVOS are spread according to a pattern of animals per location (XY-coordinate) that originates from the EMAV2.1 model.

### 1.2.11. GNFR L : Agriculture Other

Methods for gridding the emissions per region for GNFR sector L Agriculture – Other are summarized i Table 1-12.

Table 1-12. Tier method and surrogates used for gridding of emissions in GNFR sector L_AgriOther

| GNFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|
| | | **Flanders** | **Brussels** | **Wallonia** |
| **L_AgriOther** | Tier 3 | Point Sources | - | - |
| | Tier 2 | - | - | Agricultural plots |
| | Tier 1 | - | Agricultural surfaces | - |

Brussels Capital Region reports emissions from agricultural soils. Emissions are allocated according to agricultural surfaces per municipality.

In Wallonia, emissions of $NH_3$, NOx, NMVOC and PM coming from the agricultural soils (NFR sector 3D) have been distributed following the same approach as emissions of livestock. The 2019 Belgian statistics provide the agricultural area by municipality. This allows calculations of grazing, manure application and fertilizing emissions by municipality. The sum of these emissions is than distributed thanks to the agricultural plot across the crop and pasture areas (3).

In Flanders, the ammonia emissions coming from agricultural soils (3D) are calculated and geographically spread with the EMAV2.1 model (see also IIR Chapter 5). This calculation and spreading occurs on the level of the farm (XY-coordinate). The emissions of NO (reported as NOx)

and NMVOS are spread according to a pattern of manure-N applied, inorganic N-fertilizer applied, or the available cropland/grassland per location (XY-coordinate).

### 1.2.12. GNFR M : Other

1

Belgium does not estimate emissions in the GNFR sector M Other.

### 1.2.13. GNFR N : Natural

Methods for gridding the emissions per region for GNFR sector N Natural are summarized in Table 1-13.

Table 1-13. Tier method and surrogates used for gridding of emissions in GNFR sector N_Natural

| GNFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|
| | | Flanders | Brussels | Wallonia |
| N_Natural | Tier 2 | Forest and grassland statistics | Not applicable | Forest and grassland statistics |

In Wallonia, this sector is distributed using the Sector Plan covering forests.

In Flanders, the emissions of this sector are distributed based on the available cropland/grassland and forest areas in Flanders.

### 1.2.14. GNFR O : AviCruise

The mapping of the sector “Aviation cruise” wasn’t estimated following the EMEP guidebook: “Emissions from domestic cruise and from international aircraft flights should be excluded from the mapping as these are estimated centrally by EMEP”.

### 1.2.15. GNFR P : IntShipping

| GNFR | Tier | surrogates for gridding | | |
|---|---|---|---|---|
| | | Flanders | Brussels | Wallonia |
| P_IntShipping | Tier 3 | geographic dataset of ship movements on shipping routes and in harbours | Not applicable | Not applicable |

Emissions of international fishing (1A3di(i)) are part of the EMMOSS model, and are calculated in Flanders. Because all emissions of international fishing take part in the Channel (North Sea), and this sea falls outside the grid attributed to Belgium, the emissions of national fishing are not included in the gridded data.

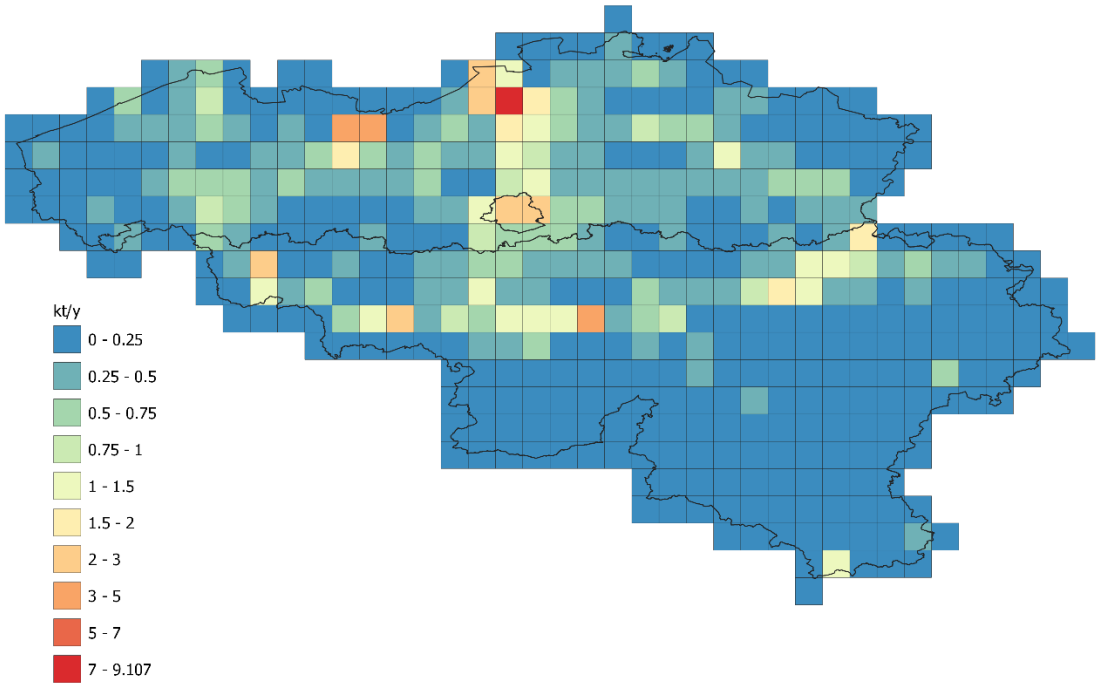
Emissions from maritime shipping (shipping routes mainly in the North Sea that are not part of the EMEP grid, and ports) are distributed in proportion to a geographic dataset of ship movements.

Because a part of the emissions of international maritime navigation (1A3di(i)) falls outside the grid attributed to Belgium, a difference between the gridded data (annex v) and the data reported for the NFR-code 1A3di(i) (annex I) occurs.

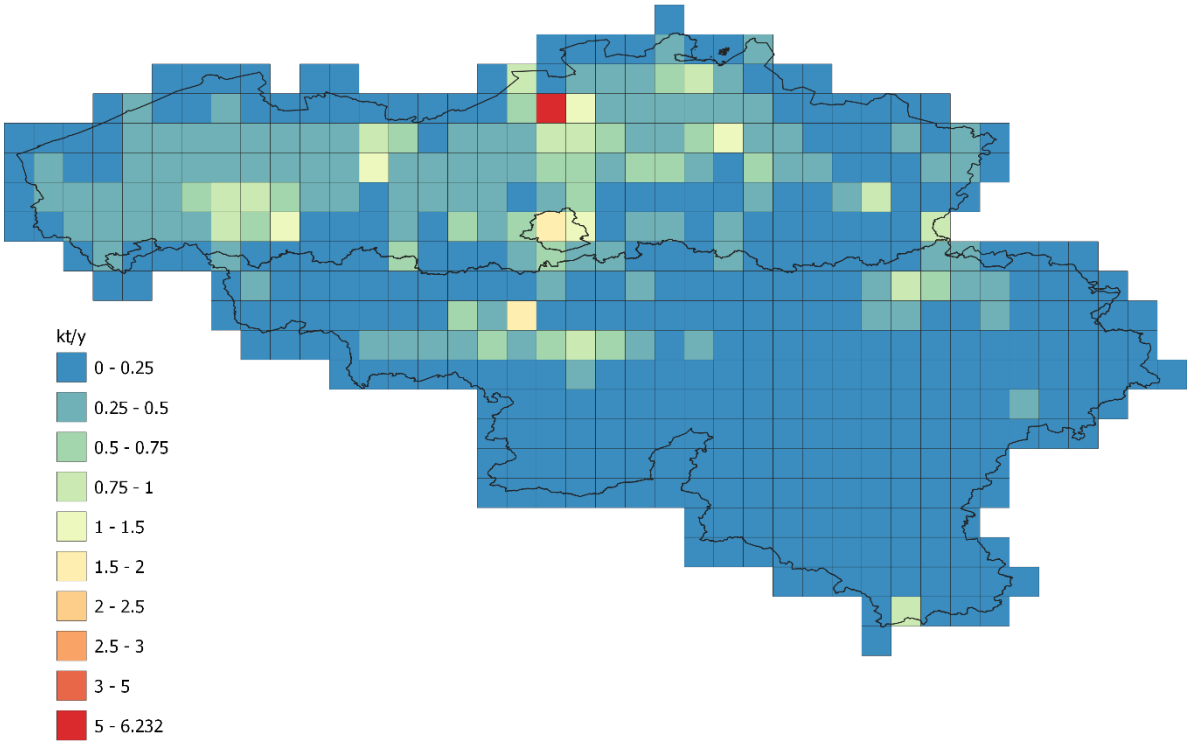
## 1.3. *Gridded emissions: Results*

The following figures show the gridded national totals for $NO_x$, NMVOC, $SO_x$, $NH_3$ and PM2.5. In general the largest parts of the emissions are located in the most densely populated regions in the North of Belgium. Antwerp is a hot spot for most pollutants due to its great industrial, urban and traffic activities. For $NH_3$, the greatest source is agriculture, with a large activity in the North West of Belgium. Large PM emissions in the Ghent harbour are coming from 1 industrial company.

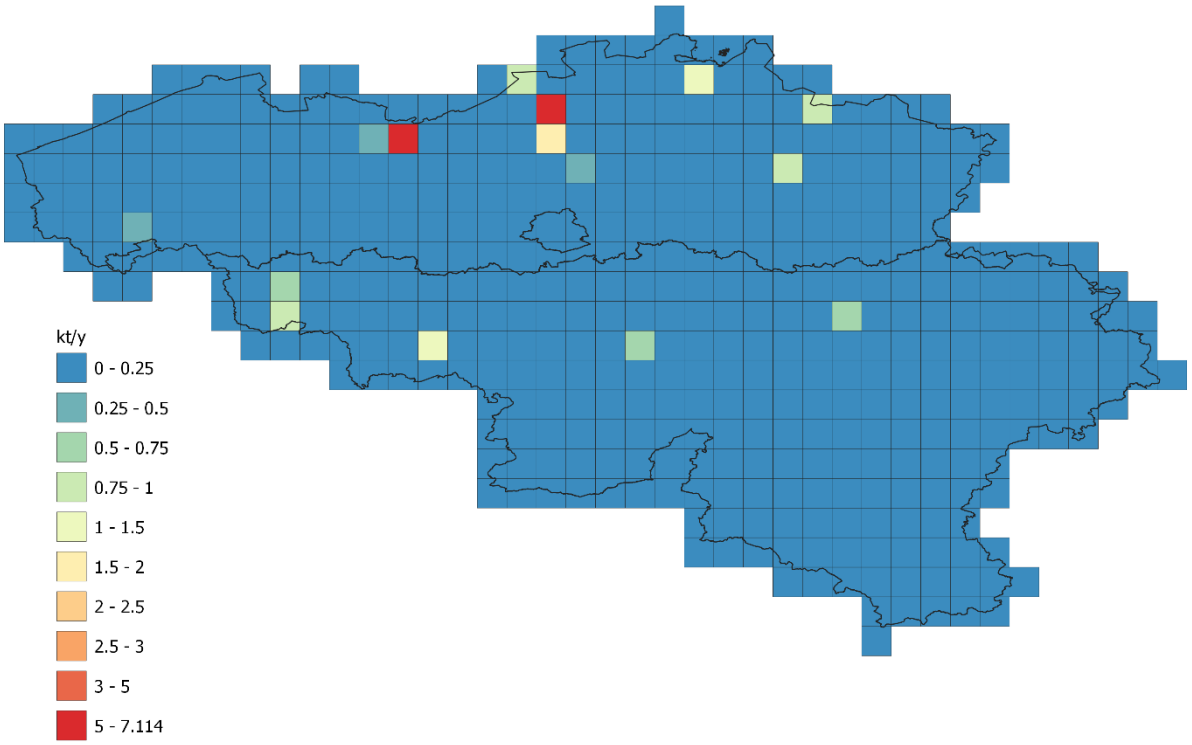
## National Total NOx, 2019



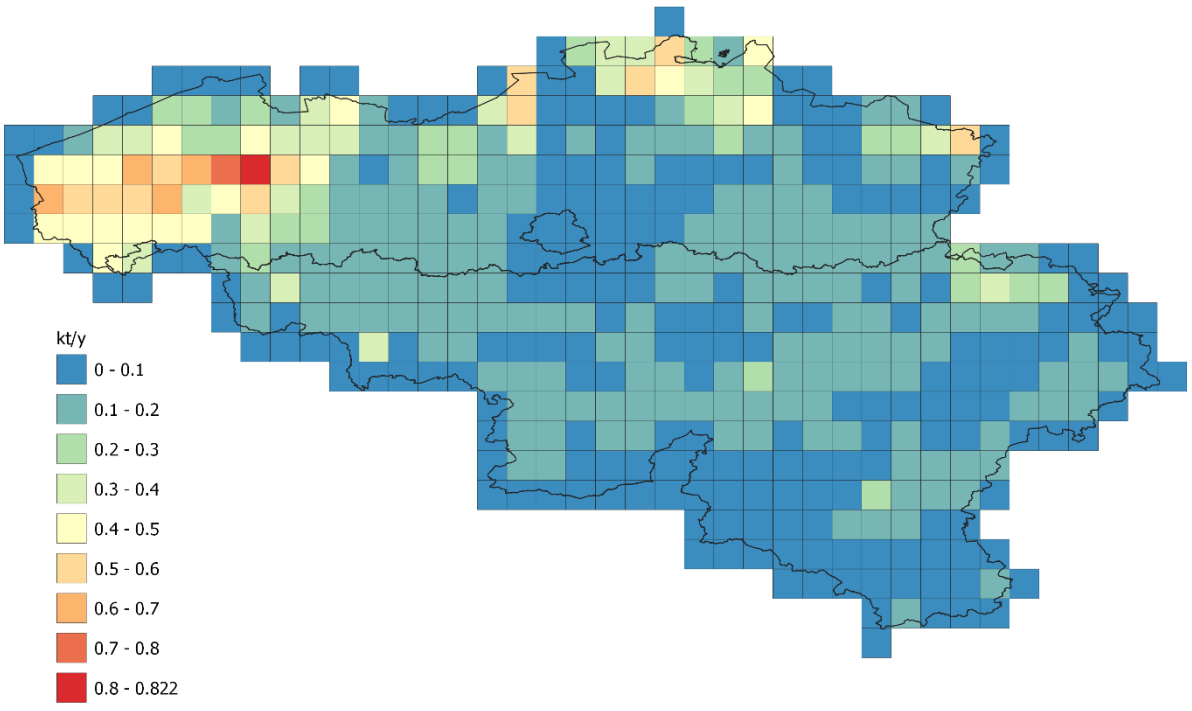

## National Total NMVOC, 2019



## National Total SOx, 2019




## National Total NH3, 2019



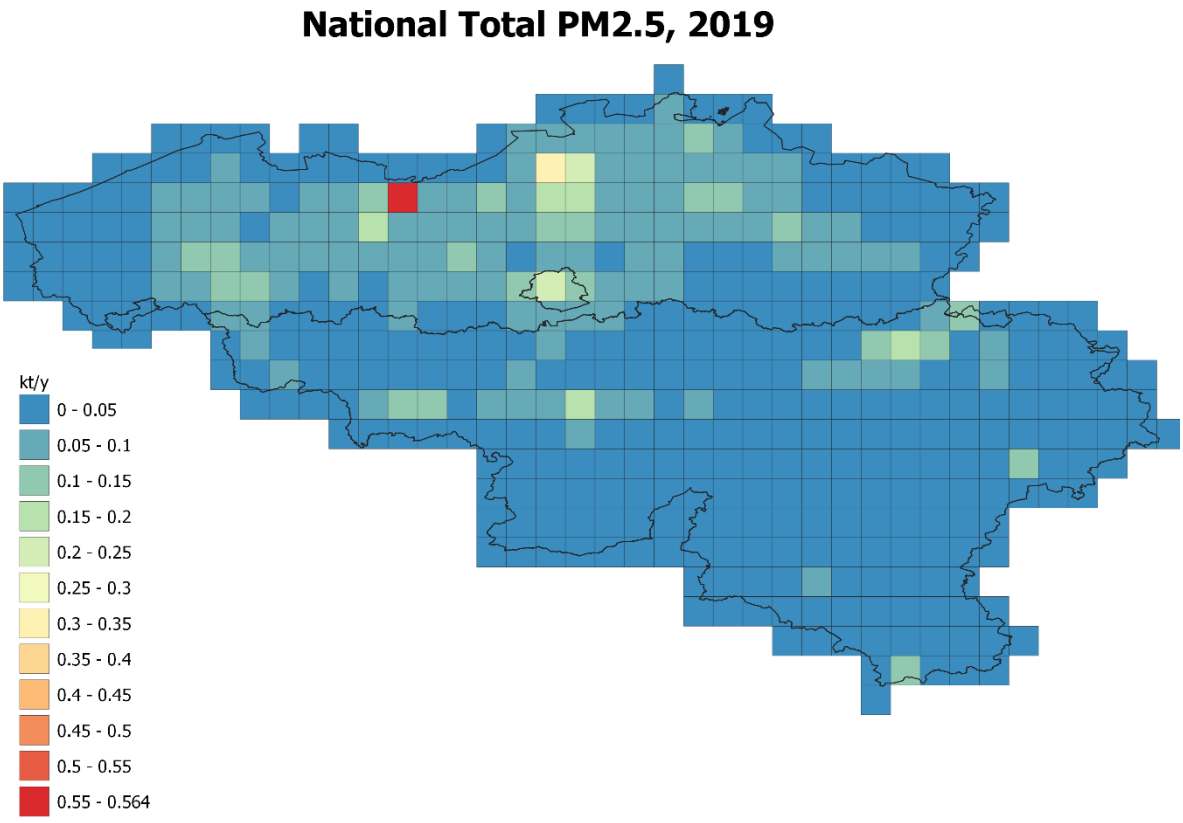



Figure 1-3: Gridded national total emissions for NOx, NMVOC, SOx, NH3 and PM2.5 in 2019.

## 1.4. *LPS data*

Large Point Sources are defined as facilities whose combined emissions, within the limited identifiable area of the site premises, exceed at least one of the threshold values for the 14 pollutants identified in table 1 of the EMEP Reporting Guidelines. Belgium reported LPS data for 2019 according to this definition, including information on stack height class.

Belgium reported emissions for 2019 from 316 facilities, of which 229 in Flanders, 2 in the Brussels Capital Region and 85 in Wallonia. Most facilities are from the industrial or agricultural sectors. All the Walloon agricultural plants under the PRTR are now reported as LPS (21 plants).

With regard to review question BE-LPS-E-2020-0001, emissions with sub-threshold values for PRTR and/or LPS, are included in NECD reporting and were not retained in LPS reporting. This approach is applied for all emissions of pollutants which have sub-threshold values for LPS/PRTR.

The LPS emissions are used directly in the national inventory (NECD). There is no divergence between LPS and the NECD (BE-LPS-GEN-2020-0002).

For the LPS reporting, only those emissions above the threshold are reported. Under the NECD all emissions are reported (BE-LPS-E-2020-0001).

In response to the review question BE-GRID-GEN-2020-0002 we made corrections to both LPS reporting and reporting of the gridded data. For more information see section 1.2.2. GNFR B: Industry.

Table 14: Share of National Total emissions as covered by LPS emissions (BE-LPS-GEN-2020-0006)

| | NOx (as $NO_2$) | NMVOC | SOx (as $SO_2$) | NH3 | PM2.5 | PM10 | CO | Pb | Cd | Hg | PCDD/PCDF | PAHs | HCB | PCBs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kt | kt | kt | kt | kt | kt | kt | t | t | t | g I-Teq | t | kg | kg |
| **National Total Emissions** | | | | | | | | | | | | | | |
| **Belgium (2019)** | 160.22 | 112.82 | 29.50 | 66.50 | 18.41 | 27.38 | 369.02 | 14.59 | 1.19 | 1.03 | 29.04 | 6.71 | 3.07 | 14.26 |
| **LPS Emissions** | | | | | | | | | | | | | | |
| **Belgium (2019)** | 39.05 | 16.82 | 25.09 | 2.95 | 1.17 | 1.92 | 198.00 | 7.07 | 0.30 | 0.63 | 7.19 | 0.32 | 0.62 | 13.83 |
| **Flanders (2019)** | 21.58 | 12.50 | 19.99 | 1.55 | 0.63 | 1.10 | 180.66 | 6.13 | 0.21 | 0.18 | 4.88 | | | |
| **Wallonia (2019)** | 17.31 | 4.20 | 5.10 | 1.40 | 0.54 | 0.83 | 17.34 | 0.94 | 0.10 | 0.45 | 2.32 | 0.32 | 0.62 | 13.83 |
| **Brussels (2019)** | 0.16 | 0.12 | | | | | | | | | | | | |
| **Share LPS as % of National Total Emissions** | | | | | | | | | | | | | | |
| **Belgium (2019)** | 24.37 | 14.91 | 85.05 | 4.43 | 6.36 | 7.02 | 53.66 | 48.47 | 25.49 | 61.46 | 24.77 | 4.79 | 20.34 | 96.99 |
| **Flanders (2019)** | 13.47 | 11.08 | 67.75 | 2.33 | 3.41 | 4.00 | 48.96 | 42.04 | 17.50 | 17.27 | 16.79 | | | |
| **Wallonia (2019)** | 10.81 | 3.73 | 17.30 | 2.10 | 2.95 | 3.02 | 4.70 | 6.43 | 8.00 | 44.20 | 7.98 | 4.79 | 20.34 | 96.99 |
| **Brussels (2019)** | 0.10 | 0.10 | | | | | | | | | | | | |

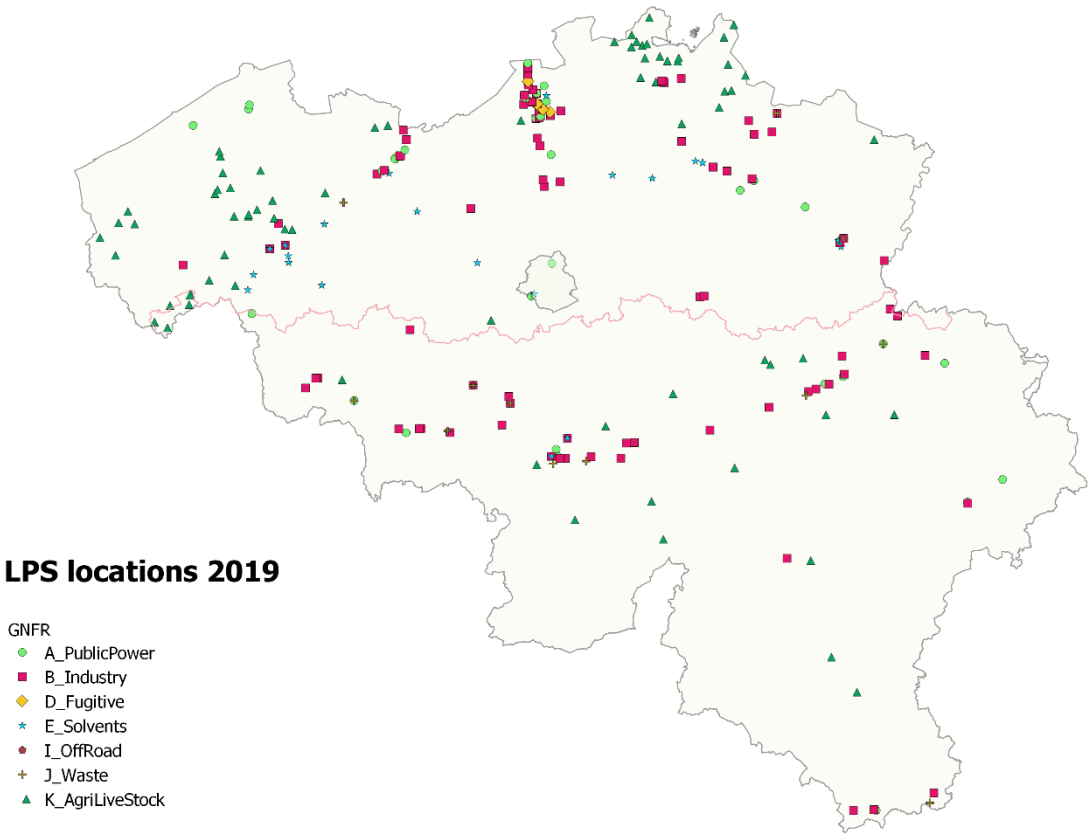



Figure 1-4: Location of LPS in 2019

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