



UNECE

Webinar on gridded emissions
12 March 2024

Preliminary information on context, principles and mapping techniques



Webinar on EMEP gridded air emission inventories

- Welcome and introduction
- Emission reporting under the UNECE Convention on Long-Range Transboundary Air Pollution
- Introduction about Georgia situation and survey results
- Basic principles of spatialization methods to produce gridded emissions
- The EMEP grid
- Introduction on GIS techniques and QGIS
- Insights on frequent issues
- Preliminary programme on the Tbilisi workshop
- Q&A

Introduction about Georgia situation and survey results

Webinar on gridded emissions

Previous workshops

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- 2017 : Projections + EMEP (introduction)
- 2021 : EMEP mapping of emissions (complete overview)

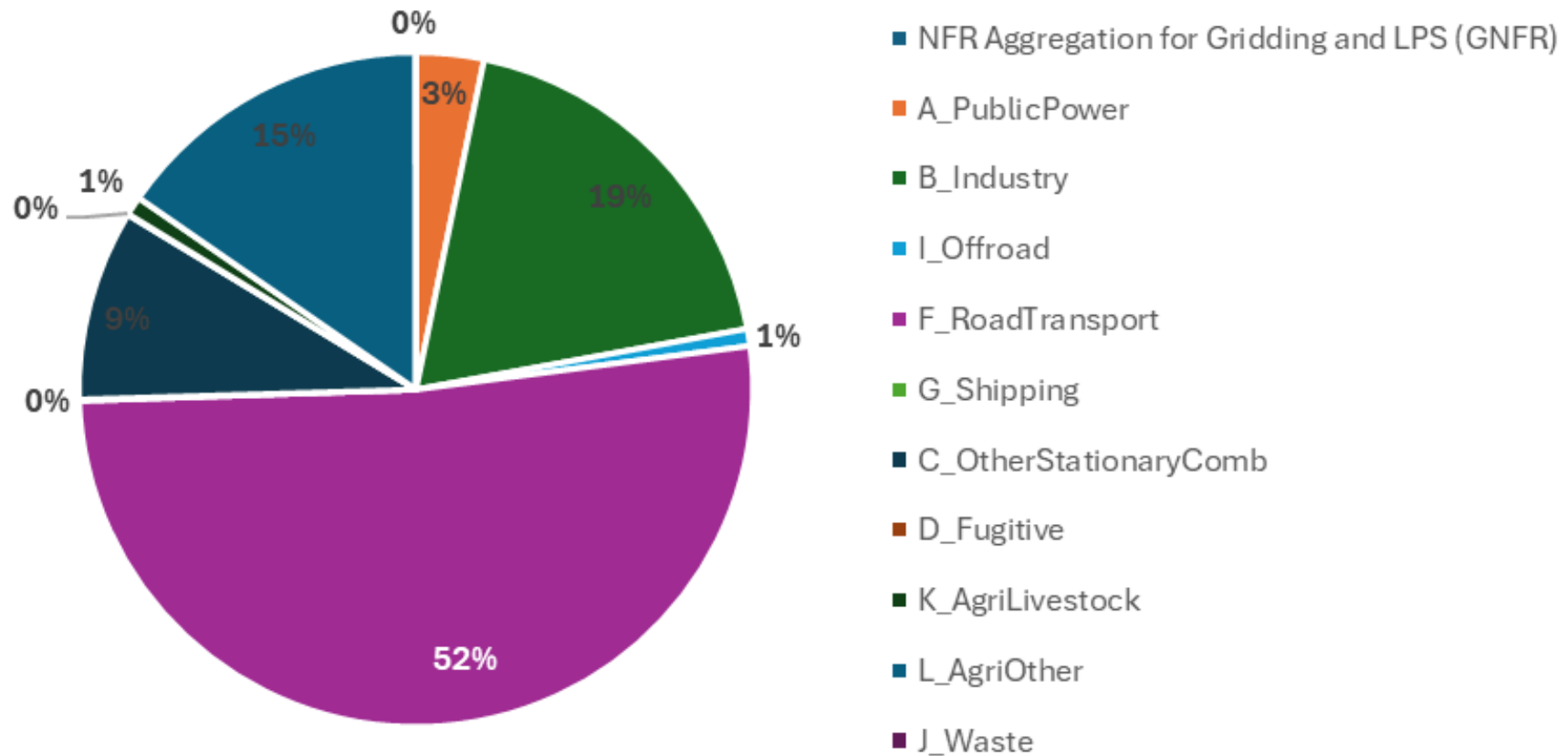
- 2024 (april)

Latest NFR submission

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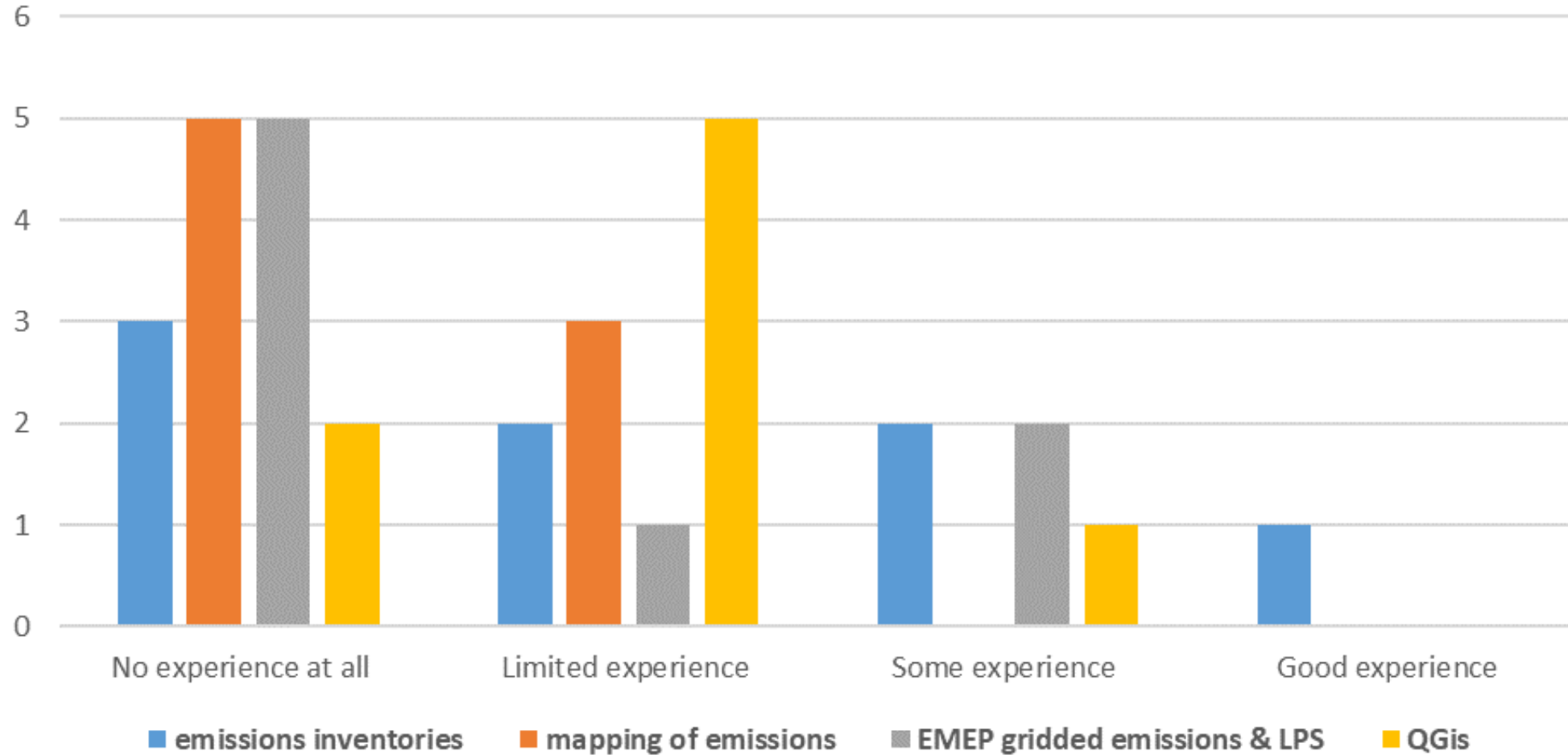


Nox emissions in 2022 (NFR 2024)



Survey results

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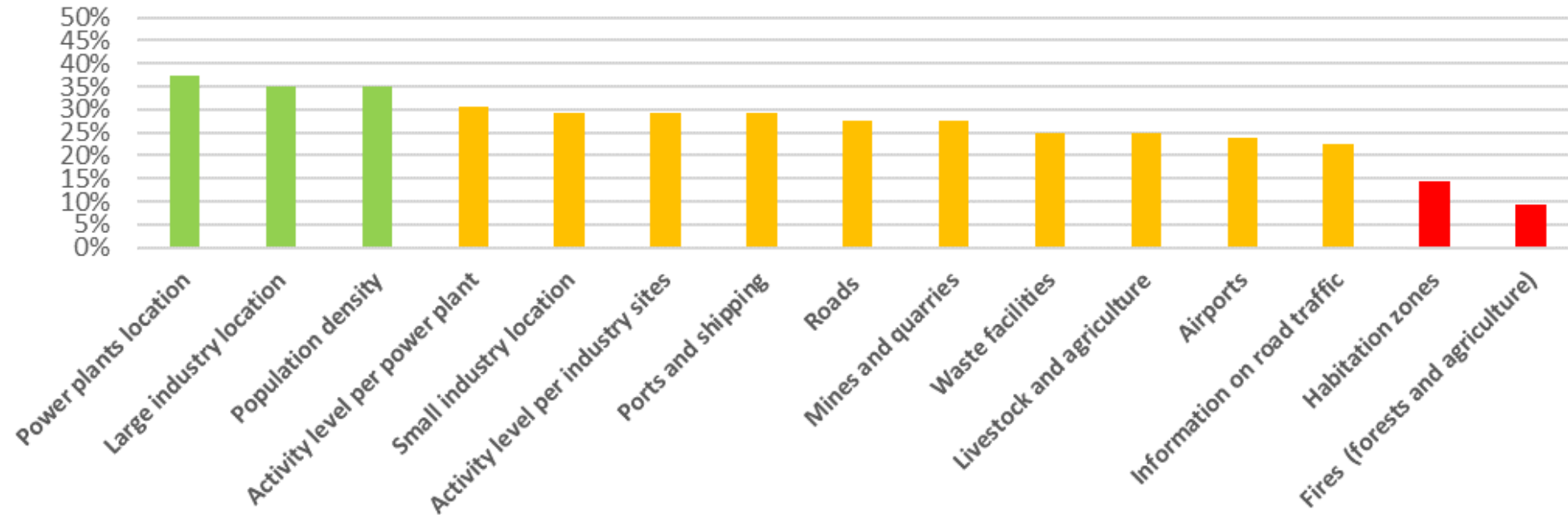


Survey results

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Level of data availability



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Basic principles of spatialization methods to produce gridded emissions

Webinar on gridded emissions



EMEP Guidebook chapter 7



European Environment Agency



Category

General guidance

Title

Spatial mapping of emissions

Version

Guidebook 2023



An inventory process

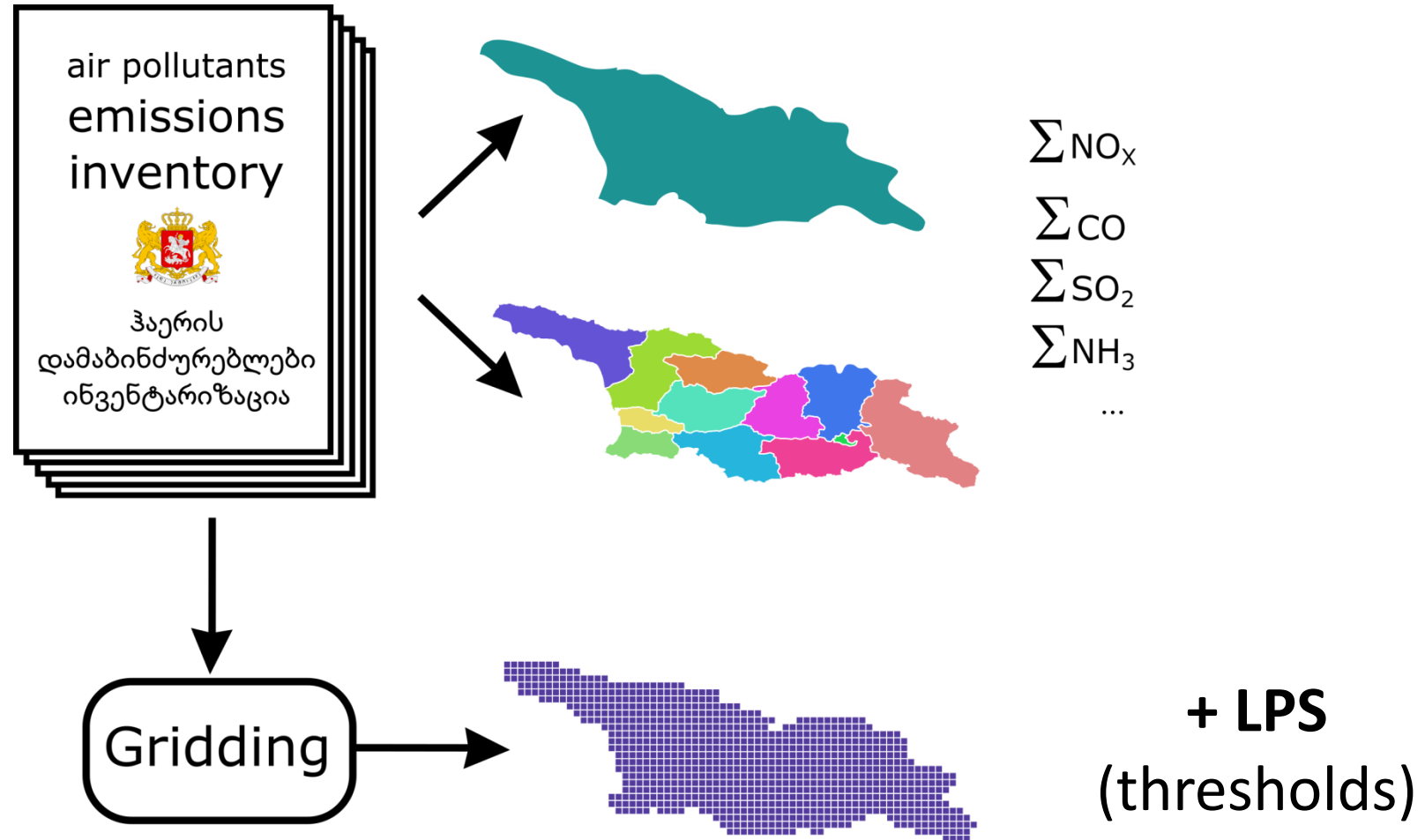
- Spatial mapping of emissions can be done by spatial model / GIS expert, but it requires a fine knowledge of the inventory sources.
- Spatial mapping of emissions is above all emissions data preparation, a work of disaggregating emissions in sources relevant for mapping, and the control of consistency with the inventory

- The EMEP grid,
- Objects on the map (grid, polygons, points),
- Emissions...
 - can all be treated as **tables**.
 - Data tables are called “attribute tables” in GIS
- The EMEP gridded emissions preparation involves often more work on tables in Excel than work in GIS.



- The gridded inventory is not another inventory but it is the existing emission inventory put on a map
- The inventory tells how many emissions, the gridded map tells where
- The more precise and accurate the inventory, the easier the map is constructed

Consistency





- Spatialization is the process of assessing where emissions happen...
...and attribute emissions to their exact or supposed location
- This spatial allocation does not modify the inventory results, it only distributes the totals on the map
- Spatialization involves using GIS and geographical datasets
- It involves allocate **stationary and diffuse emissions** on :
 - point sites (known location and known associated emissions),
 - linear sites (known location and supposed emissions)
 - areas with surrogate proxies (indicators).
- All stationary emissions exact location are not always known
 - Stationary sources can be allocated to areas



Spatialization

- An inventory cannot directly be spatialized unless every source is known (every house, cattle, traffic...) by a bottom-up approach
- There is a need for additional data
- Proxy or surrogate data does not say where it is, but indicates where it is supposed to be. This supposition should be clear and credible.



Spatialization

- Spatialization requires specific tools, data and knowledge :
 - Use of GIS softwares
 - Management of spatial proxies
 - Good understanding of air pollutants sources
 - Selection of relevant geographic datasets
 - Check quality and accuracy of spatialization
 - Master a specific vocabulary

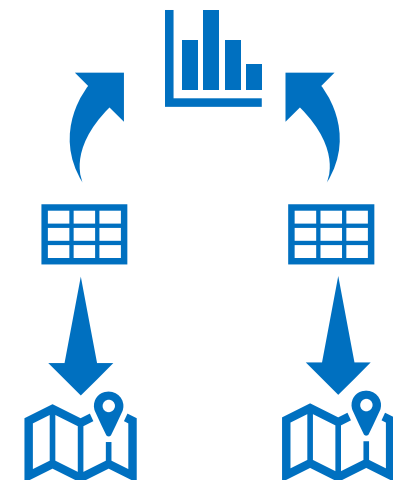
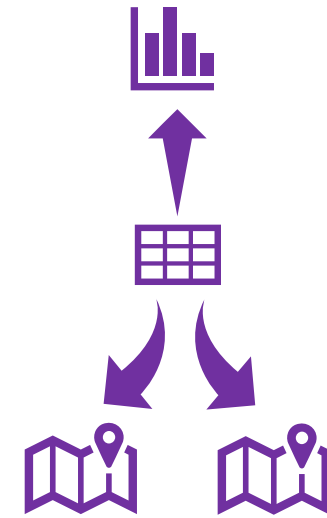


Spatialization

- Top-down spatial disaggregation of national inventory

vs.

- Bottom-up inventory calculated for each source and nationally aggregated





Basic principle:

$$\blacksquare E_{cell} = E_{total} * \frac{P_{cell}}{P_{total}}$$

E: emissions

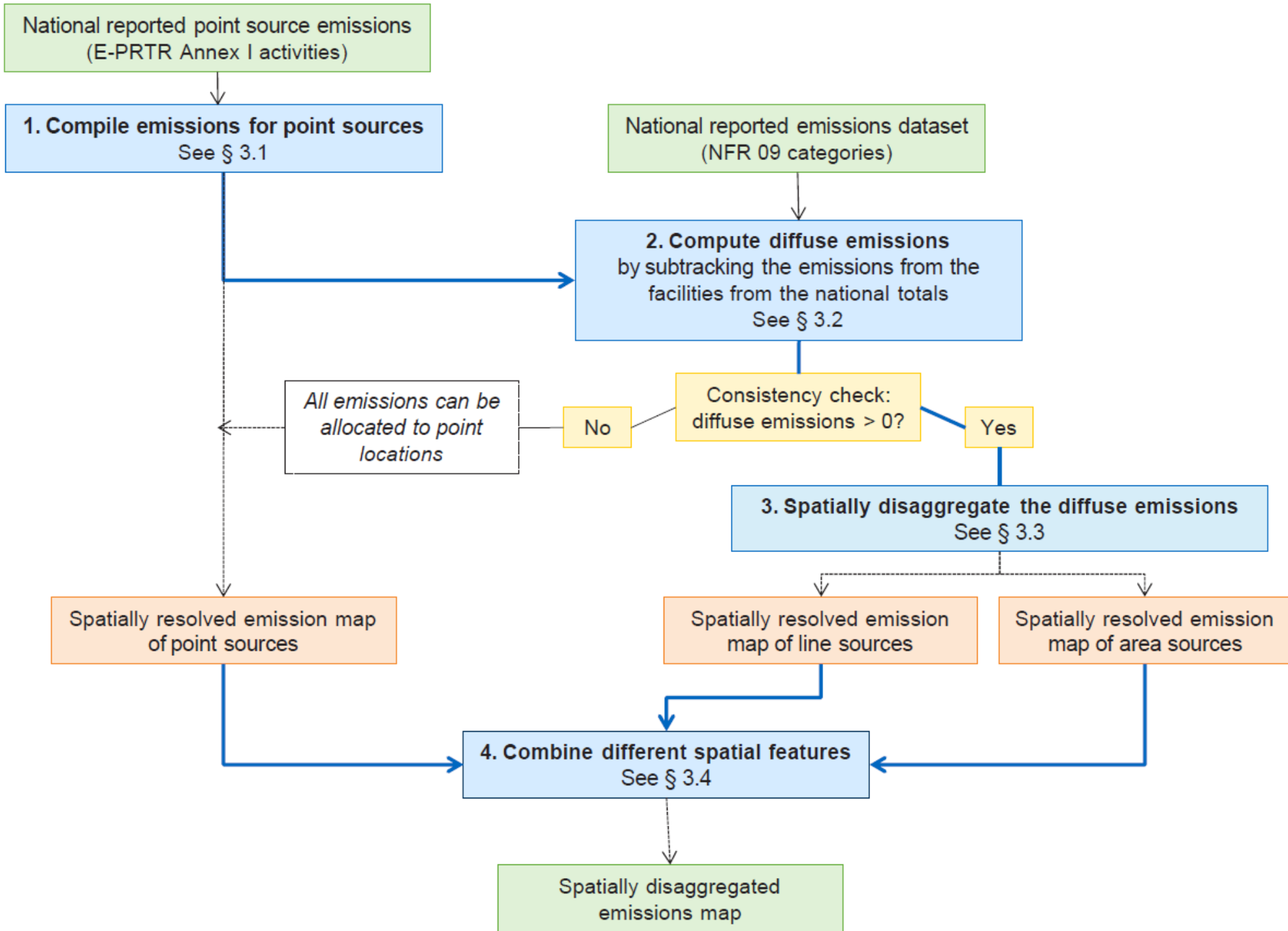
P: proxy data value within the geographical feature

This calculation is done with excel once GIS results exported, for each cell.



Tiered approach

- **Tier 3 methods** will include estimates that are based on closely related spatial activity statistics, e.g. road traffic flows by vehicle type, spatial fuel consumption data by sector (e.g. boiler use data).
- **Tier 2 methods** will be based on the use of surrogate statistics. However, for Tier 2, these statistics need to relate to the sector and could include detailed sector specific employment, population or household size and number.
- **Tier 1 methods** will include the use of loosely related surrogate statistics such as urban rural land cover data, population.



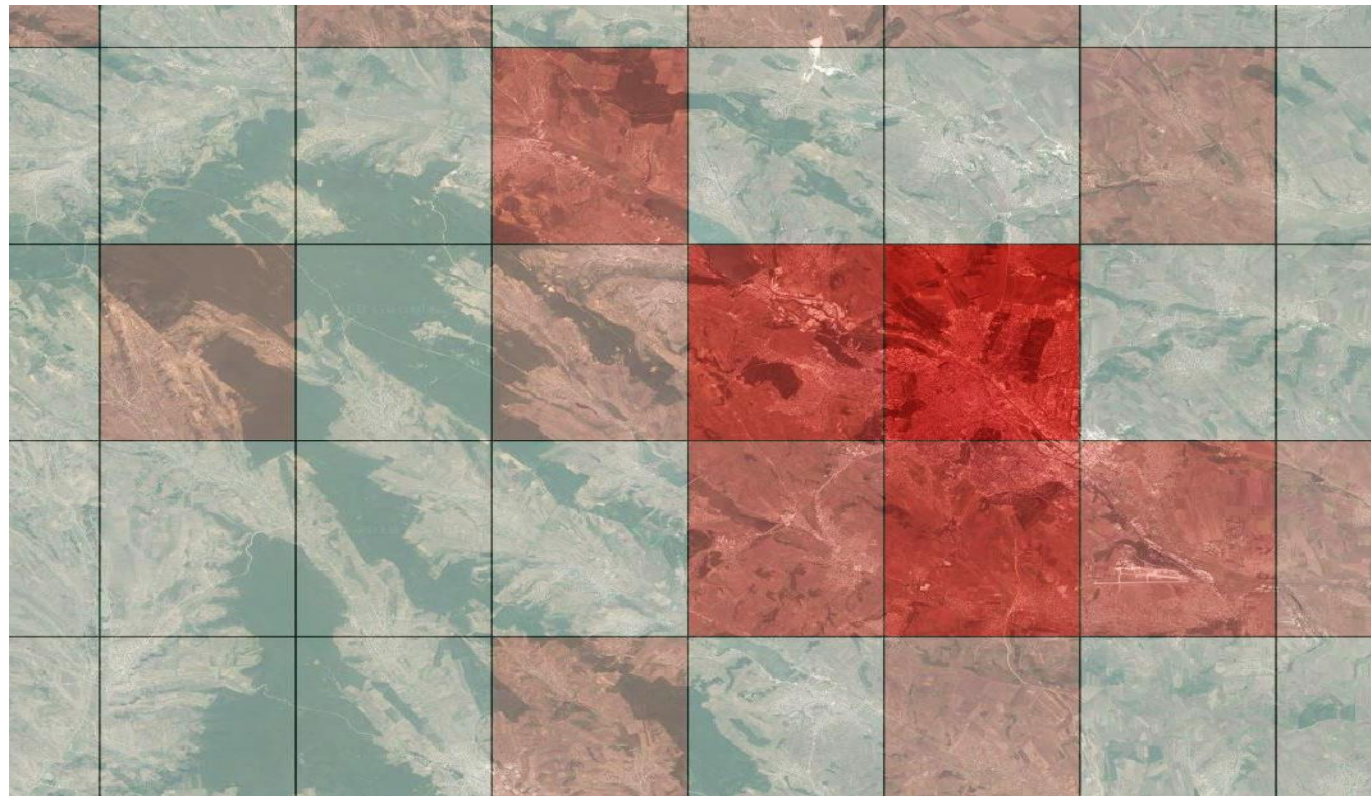


Why using a grid ?

- Why using a grid and not directly put the emissions on the point sources or on polygons ?
- The grid allows to resolve the use of different forms of data, with different:
 - Shapes
 - Spatial resolution
 - Degree of precision
- It also ensures an homogeneity at the whole EMEP zone level, for modelling

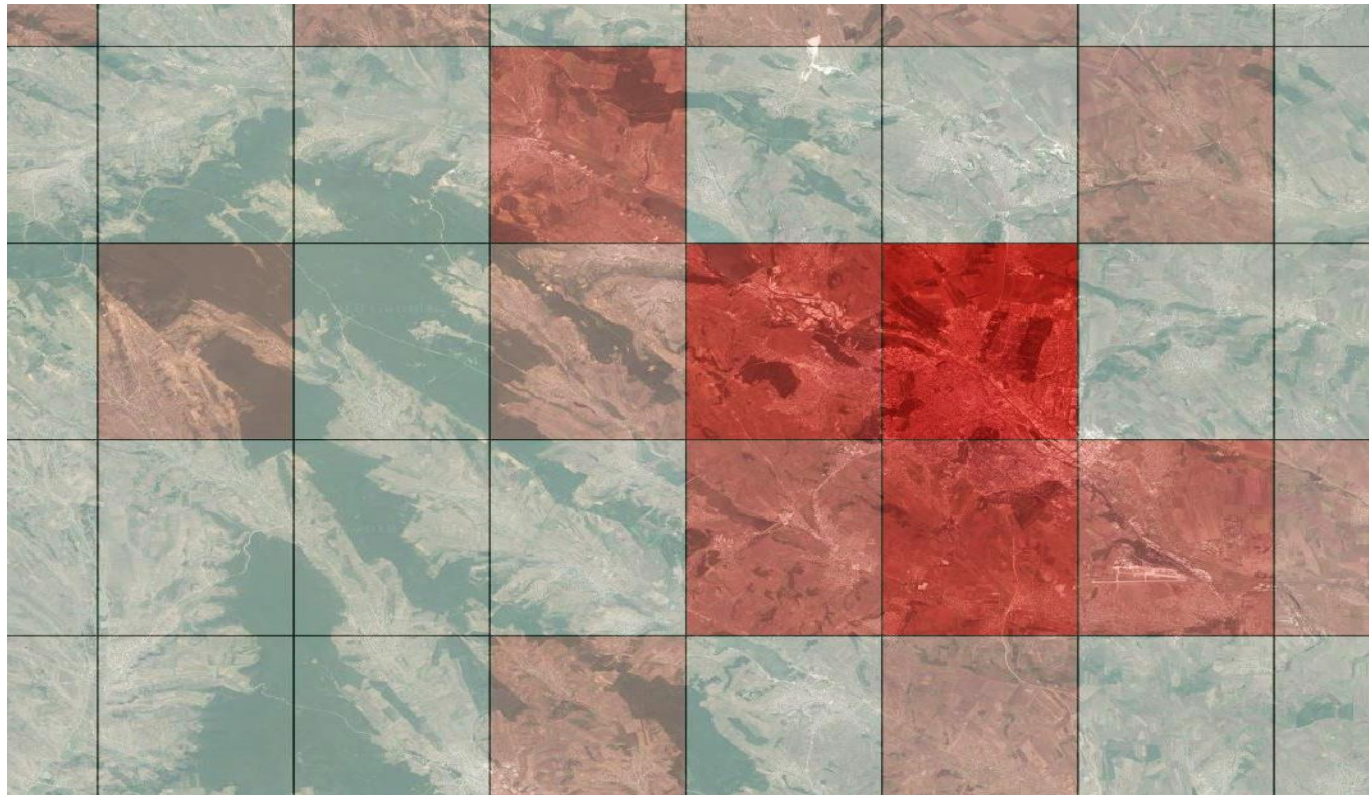


- A map to understand and help to improve and manage emission reduction plans





- A map to verify and check if the spatialization process produced credible and robust content





Spatialization quality

- For each sector of the inventory, you can specify a degree of quality (high score if good activity data + good emission factor, even if Tier 1)
- For the spatialization, the quality can be different. A sector with good inventory quality can have bad spatialization quality.
- Spatialization quality depends on : certainty on location + certainty on breakdown (spatial disaggregation).

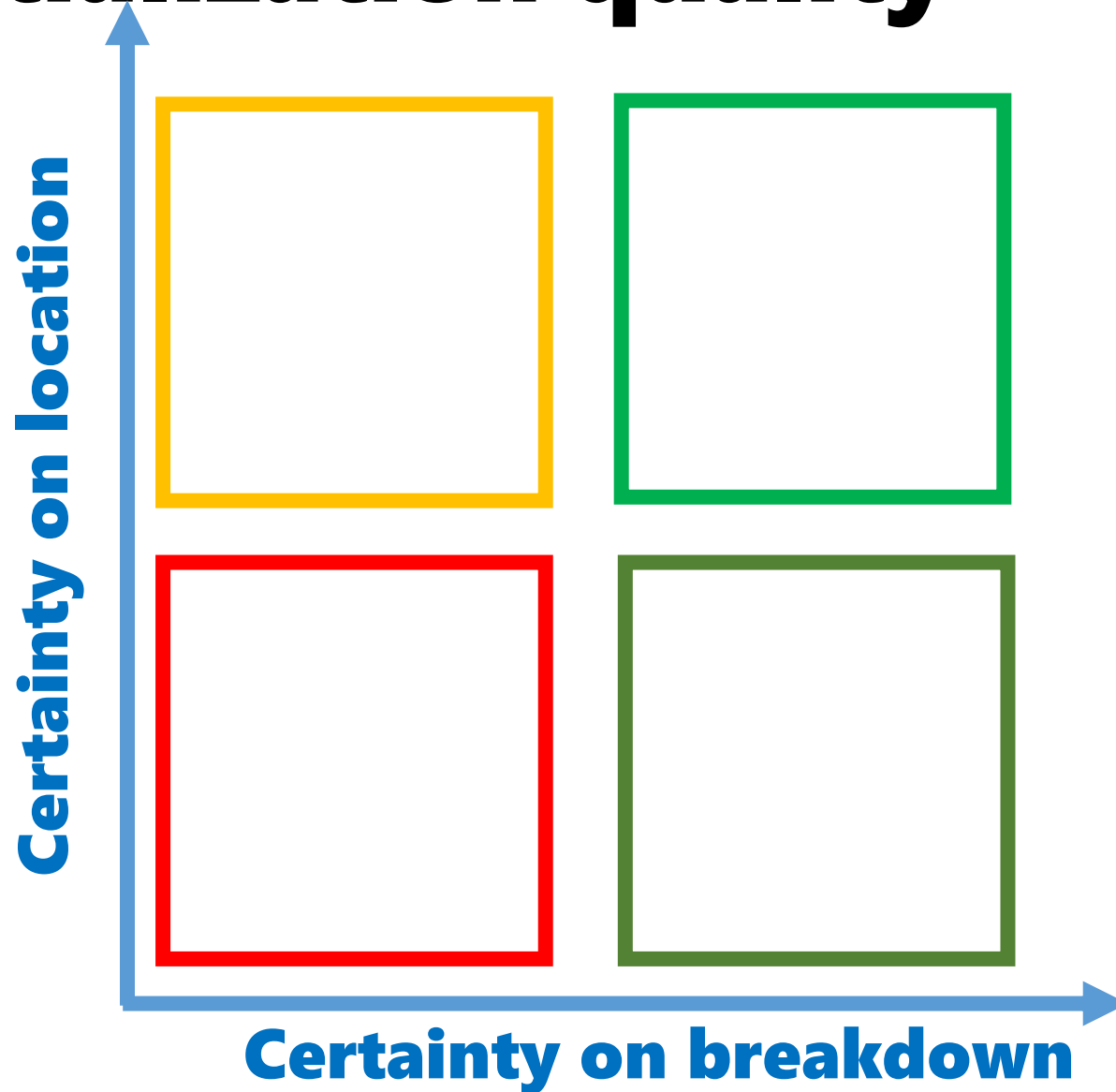
Spatialization quality

Certainty on location

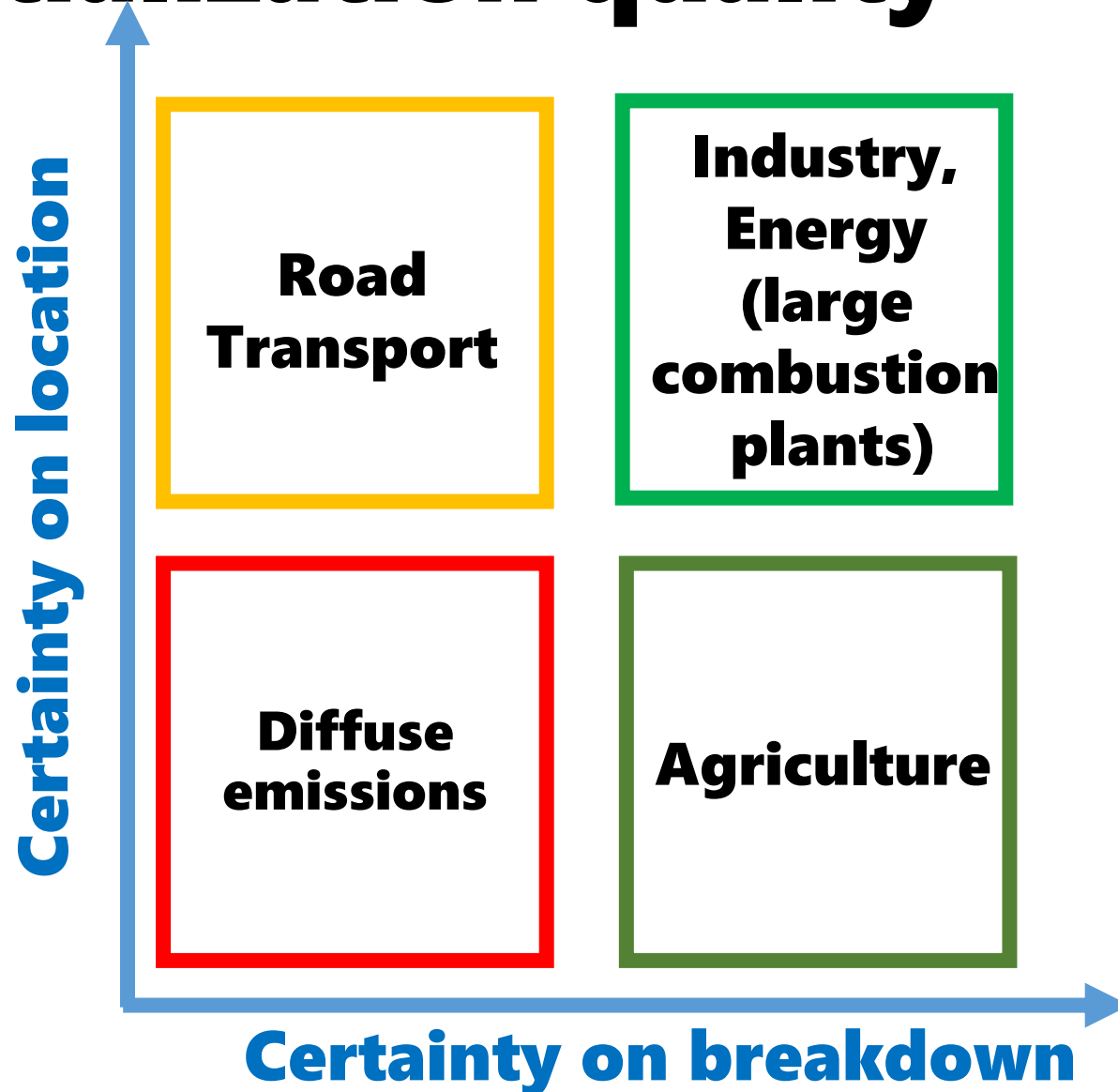


Certainty on breakdown

Spatialization quality



Spatialization quality

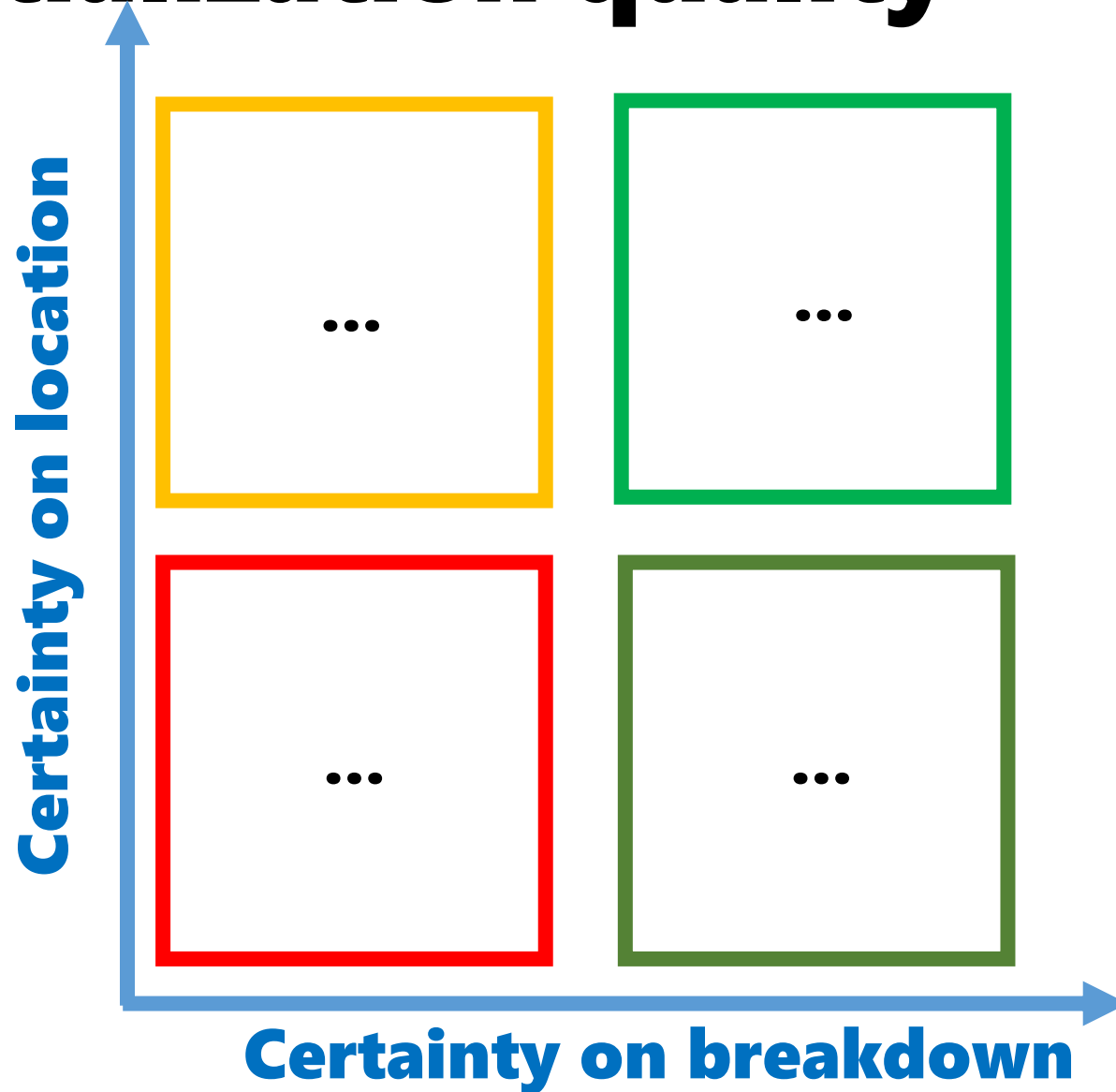


These are the typical cases

...

But what about GE?

Spatialization quality



**These are the
typical cases**

...

**But what
about GE?**

What are the types of geographical objects to map emissions ?

- Lines
- Points
- Areas
- All of the above



We have to know exactly where the emissions happen to map emissions



Yes

No

Electricity Production Plants are an example of a source of diffuse emissions



Yes

No

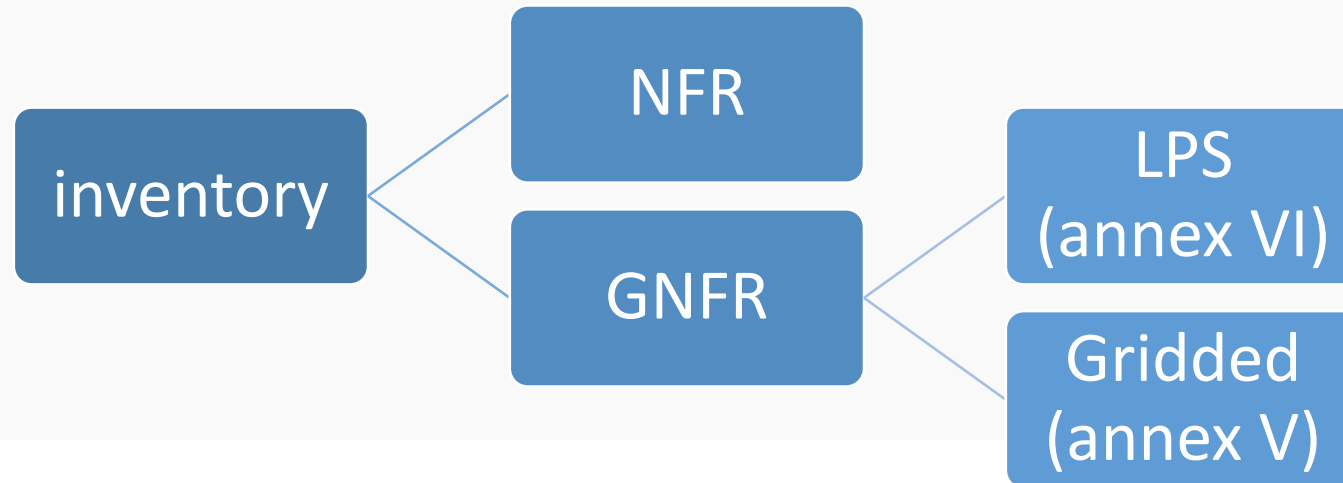
Reporting requirements & the EMEP grid

Webinar on gridded emissions



EMEP gridded and LPS

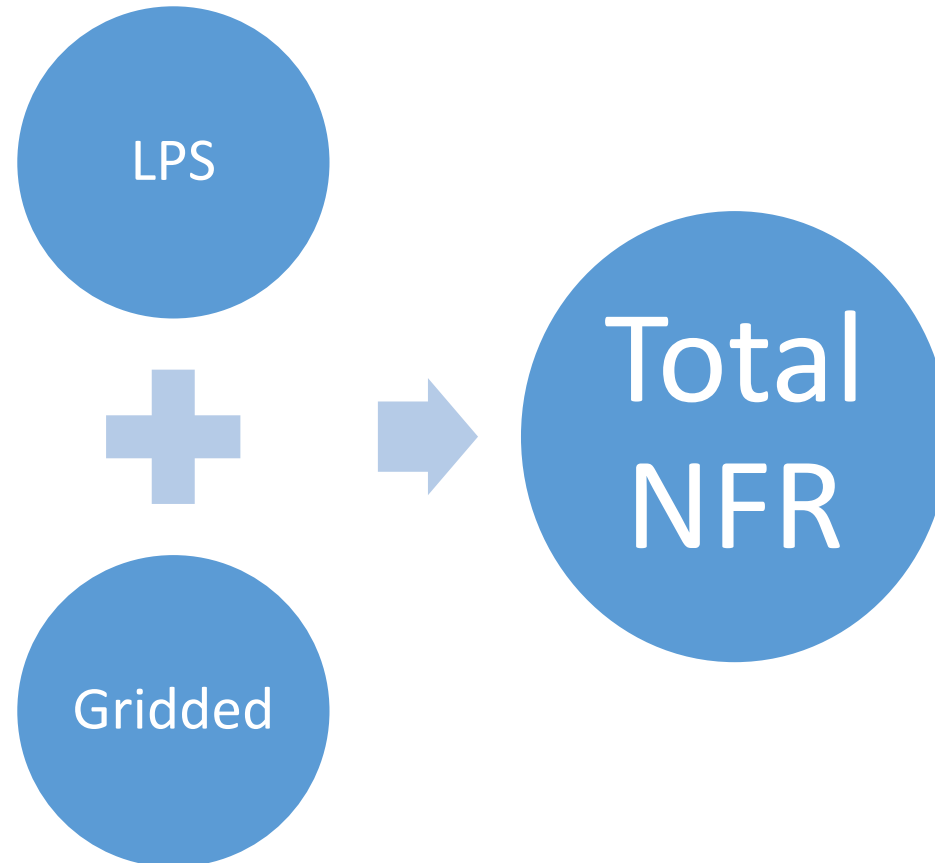
- A specific format of reporting emissions:
 - tables (annexes to the UNECE reporting)
 - Long lat informations that allows the mapping of emissions





EMEP gridded and LPS

- The Party has to indicate that there is no overlapping between LPS and gridded emissions





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- **ECE/EB.AIR.128 , par.28**
- « Emission data calculated by Parties within the **geographic scope of EMEP** shall be spatially allocated in the **EMEP grid** [and] calculated using national data sets appropriate to each (...) **source category** in accordance with the EMEP/EEA Guidebook. »
- *The EMEP domain covers the geographic domain between 30°N–82°N latitude and 30°W–90°E longitude*
- *(par. 14) The “EMEP grid” refers to a 0.1°×0.1° latitude-longitude projection [WGS 84]. (if not technically or economically feasible, a Party may calculate gridded emissions in a grid of approximately 50 x 50km²)*
- *Gridding NFR (GNFR) categories, defined in Annex V*



- **ECE/EB.AIR.128 , par.9**
- “**Large point sources**” (LPS) are defined as facilities whose combined emissions, within the limited identifiable area of the site premises, exceed the pollutant **emission thresholds** identified in table 1. These thresholds have been extracted from the full list of pollutants in Regulation (EC) No. 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC (EPRTR Regulation) and its annex II.6 LPS reporting is encouraged to include information on stack heights according to the stack height class categories as defined in table 2. Parties that do not report combustion emissions under any other international agreement may limit their criteria for Combustion LPS selection to greater than 300 megawatt (MW) thermal capacity



GNFR : *Gridded Nomenclature for Reporting*

A_PublicPower

B_Industry

C_OtherStationaryComb

D_Fugitive

E_Solvents

F_RoadTransport

G_Shipping

H_Aviation

I_Offroad

J_Waste

K_AgriLivestock

L_AgriOther

M_Other

N_Natural

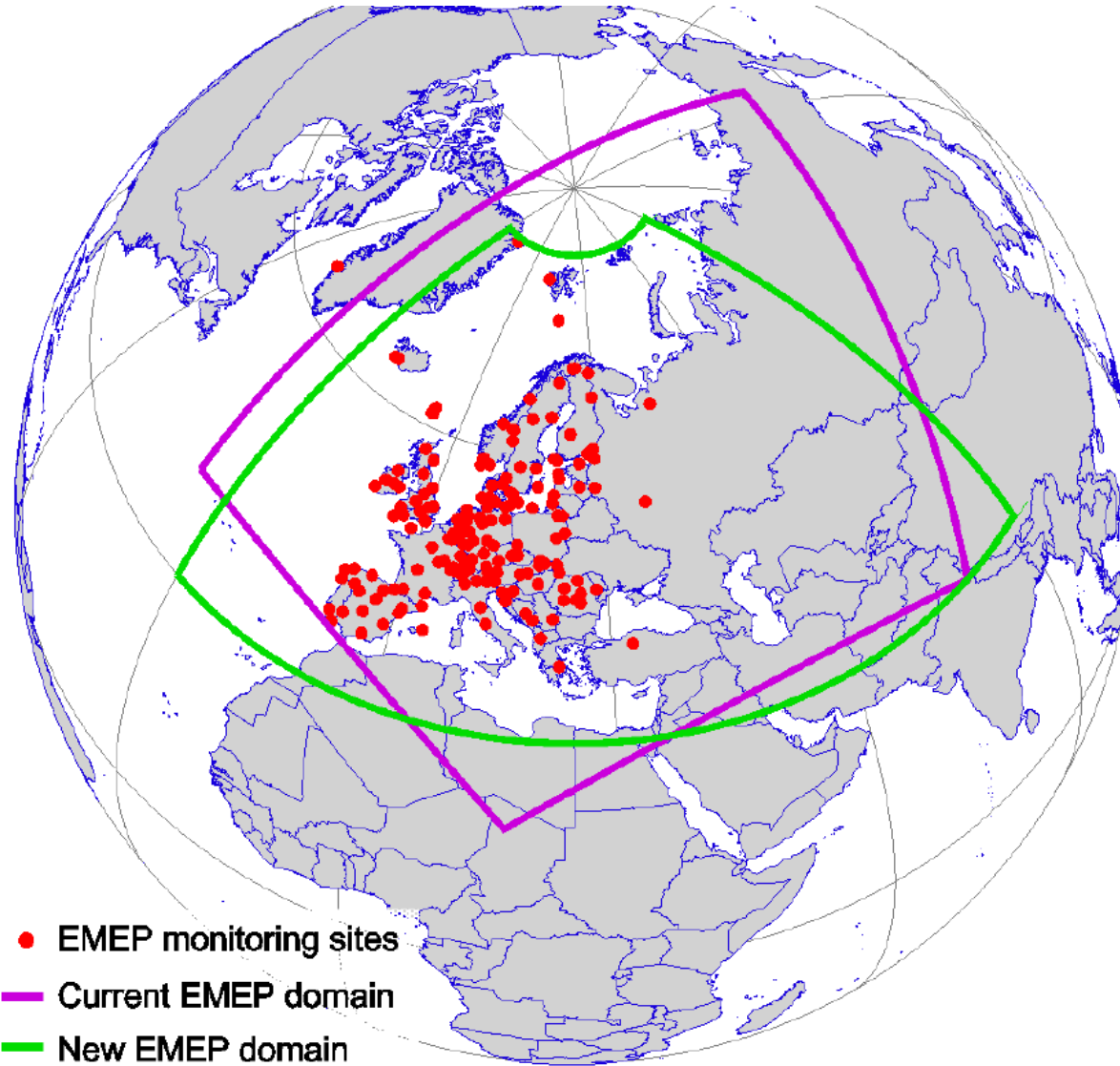
O_AviCruise

P_IntShipping

Z_Memo



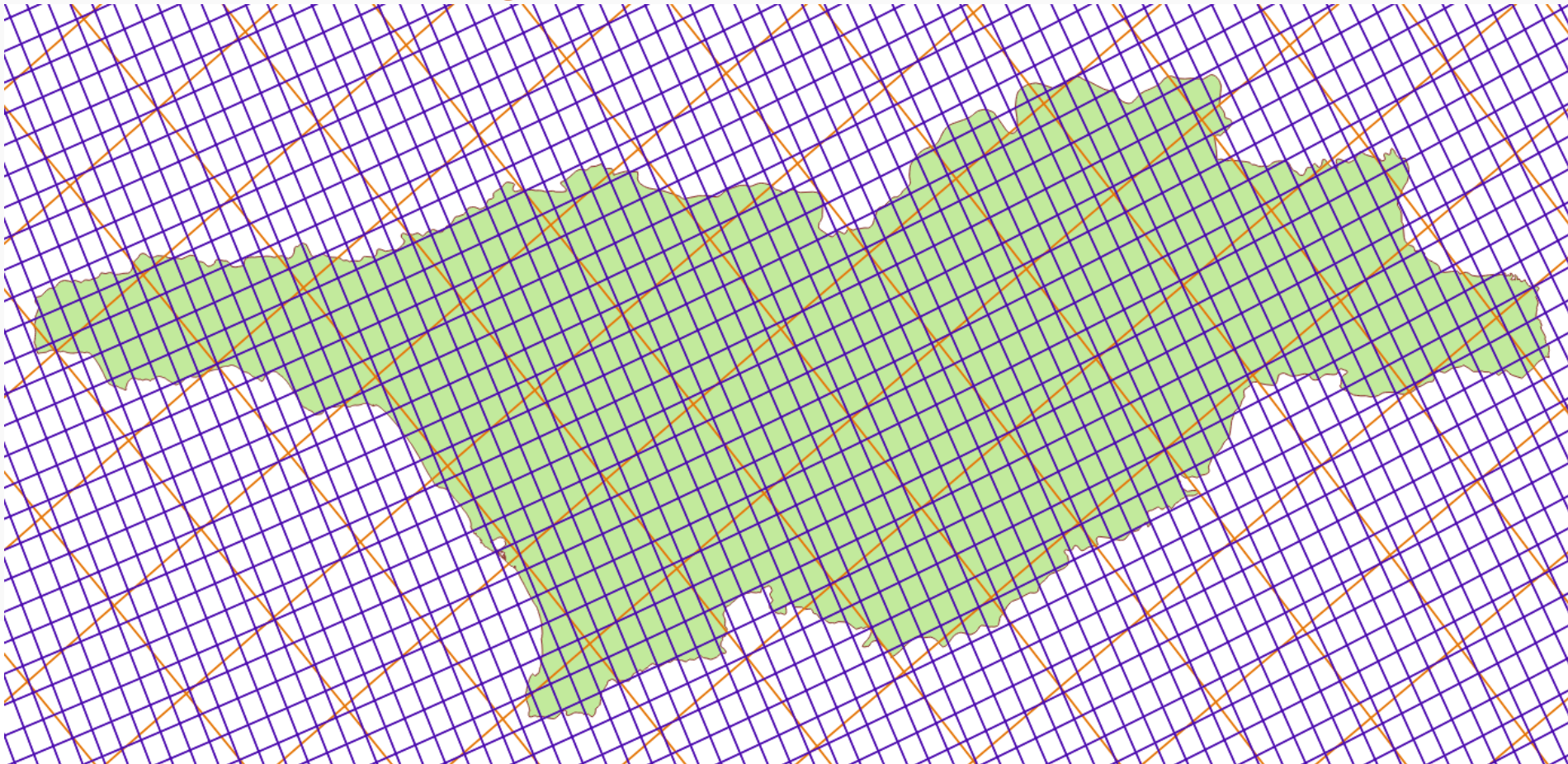
The EMEP grid





The EMEP grid

- Actual (since 2013) $0,1^{\circ} \times 0,1^{\circ}$ grid (876 cells in GE)
- Old 50*50km grid (2008-2012) (58 cells in GE)





The EMEP grid

- The grid has changed to be more precise and to cover a more convenient area
- Air quality models are more and more efficient and require more and more spatial precision, a fine spatial disaggregation of emissions
- Input data should be as precise as the grid makes one suppose so
- National inventory compilers are in better position to spatialized their own data



EMEP gridded emissions

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ANNEX V: Template file for gridded sector data for each of the relevant aggregated Gridding NFR sectors (GNFR)

NFR 2014-1

COUNTRY: **GE** (as ISO2 code)
 DATE: **14/09/2017** (as DD.MM.YYYY)
 YEAR: **2015** (as YYYY, year of emissions data)
 Version: **v1.0** (as v1.0 for the initial submission)

Add a new year

Description of table columns:

- Longitude and Latitude indicate the centre of the 0.1° x 0.1° grid cell.
- GNFR aggregated sectors must be named A_PublicPower, B_Industry, C_OtherStationaryComb, D_Fugitive, E_Solvents, F_RoadTransport, G_Shipping, H_Aviation, I_Offroad, O_AviCruise, P_IntShipping, z_Memo

VARIABLES:	Longitude	Latitude	GNFR aggregated sectors	NO _x (as NO ₂)	NMVOC	SO _x (as SO ₂)	NH ₃	PM _{2.5}	PM ₁₀	BC	CO	PI
UNIT:				kt	kt	kt	kt	kt	kt	kt	kt	kt
695	45,05	41,45	A_PublicPower	1,0103480	0,0363635	0,0063863	0,0000000	0,0045454	0,0045454	0,0001136	0,5990000	0,00
696	45,05	41,55	B_Industry	2,2195496	0,0038588	0,6437484	0,0000000	1,5206115	2,1785599	0,0701098	3,3475822	1,21
292	42,65	42,25	B_Industry	0,0684353	0,3186806	2,8513221	0,0000000	0,2899325	0,4500542	0,0251120	0,4874332	0,01
587	44,35	41,95	B_Industry	0,0222640	0,0010225	0,0003256	0,0000000	0,0005066	0,0009117	0,0000085	0,0182443	0,00
604	44,45	41,95	B_Industry	0,7685038	2,1742658	0,4224311	0,0000000	0,5598491	1,0077201	0,0000000	1,4156261	0,06
510	43,85	42,05	B_Industry	0,0217975	0,0000000	0,0153860	0,0000000	0,0113777	0,0477680	0,0003671	0,0458263	0,00
344	42,95	42,15	B_Industry	0,3791283	0,3694590	0,0012675	0,0000000	0,0091578	0,0302267	0,0219128	0,0305590	0,00
327	42,85	42,25	B_Industry	0,3469191	0,0000000	0,0012675	0,0000000	0,1227180	0,1849254	0,0219128	0,0304205	0,00
740	45,35	41,75	B_Industry	0,0028821	0,0000000	0,0197536	0,0000000	0,0000000	0,0000000	0,0089920	0,0193542	0,00
666	44,85	41,65	B_Industry	0,0028449	0,0003603	0,0071575	0,0000000	0,0022854	0,0199031	0,0010761	0,0168867	0,00
697	45,05	41,65	B_Industry	0,0012718	0,0000000	0,0000000	0,0000000	0,0001133	0,0001238	0,0000000	0,0052464	0,00
793	45,75	41,75	B_Industry	0,0011213	0,0000000	0,0000000	0,0000000	0,0000180	0,0000197	0,0000005	0,0046462	0,00



- Gridded emissions in a grid of 0.1 x 0.1 degrees shall be reported for all substances referred to in paragraph 7 of the Guidelines:
- SO_x (SO₂..), NO_x (NO₂..), NH₃, NMVOCs, CO
- PM_{2.5}, PM₁₀ (+TSP, +BC)
- Cd, Lead, Hg (+ As, Cr, Cu, Ni, Se, Zn)
- PAHs, PCDD/F, PCBs, HCB



- Every four years from 2017 onward, Parties shall report for the year Y-2 updated aggregated sectoral (GNFR) gridded emissions [...]. Gridded emissions in a grid of 0.1 x 0.1 degrees shall be reported for all substances referred to in par. 7 of these Guidelines.
- “As an alternative, a Party may report gridded emissions in a grid of approximately 50 x 50 km² until it is technically and economically feasible to switch to a grid of 0.1 x 0.1 degrees.[...]. Parties are encouraged to update their gridded [...] data and report annually where changes in spatial patterns have occurred, so that the EMEP models can represent the most up-to-date information.”

- It is best practice to report gridded emissions of previous years also.
- This mean having distinct proxies and hypothesis for each year
- This can also be the base of a modelling project, with the same EMEP grid but with higher definition + projection of future emissions

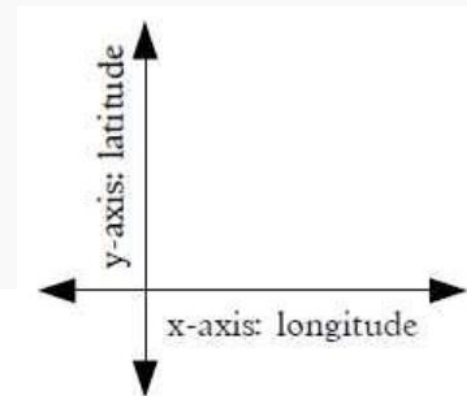


- One site = one point
- One point = one cell on the grid





- Points maps can be
 - Directly provided from registries
 - Created from addresses – long/lat from google maps, put in file with x y columns + names of sites => csv imported in Qgis (EPSG 4326 WGS 84)
 - Created by digitalization directly on the map (with xml background map/aerial photo)





Data needed

- List of sources with :
- Their coordinates – or their adress
- Their emissions

- If one info is missing, then the point procedure is not relevant : use area procedure instead.

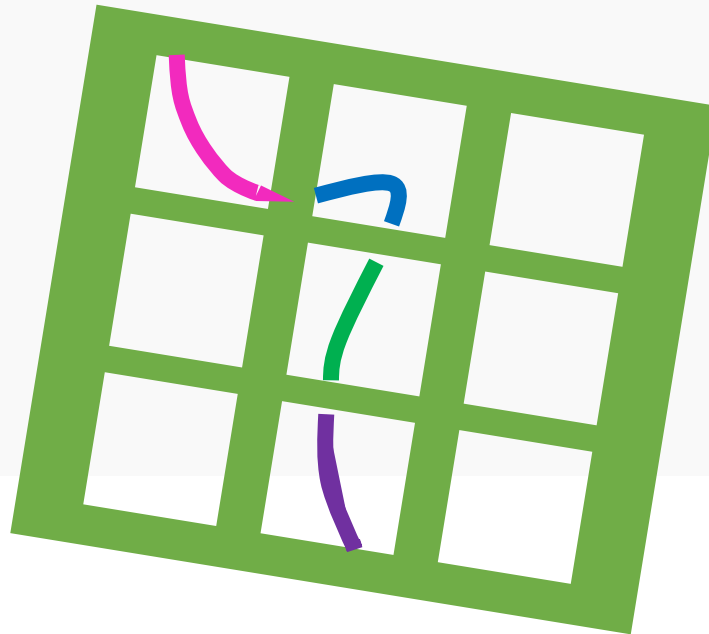


Common issues

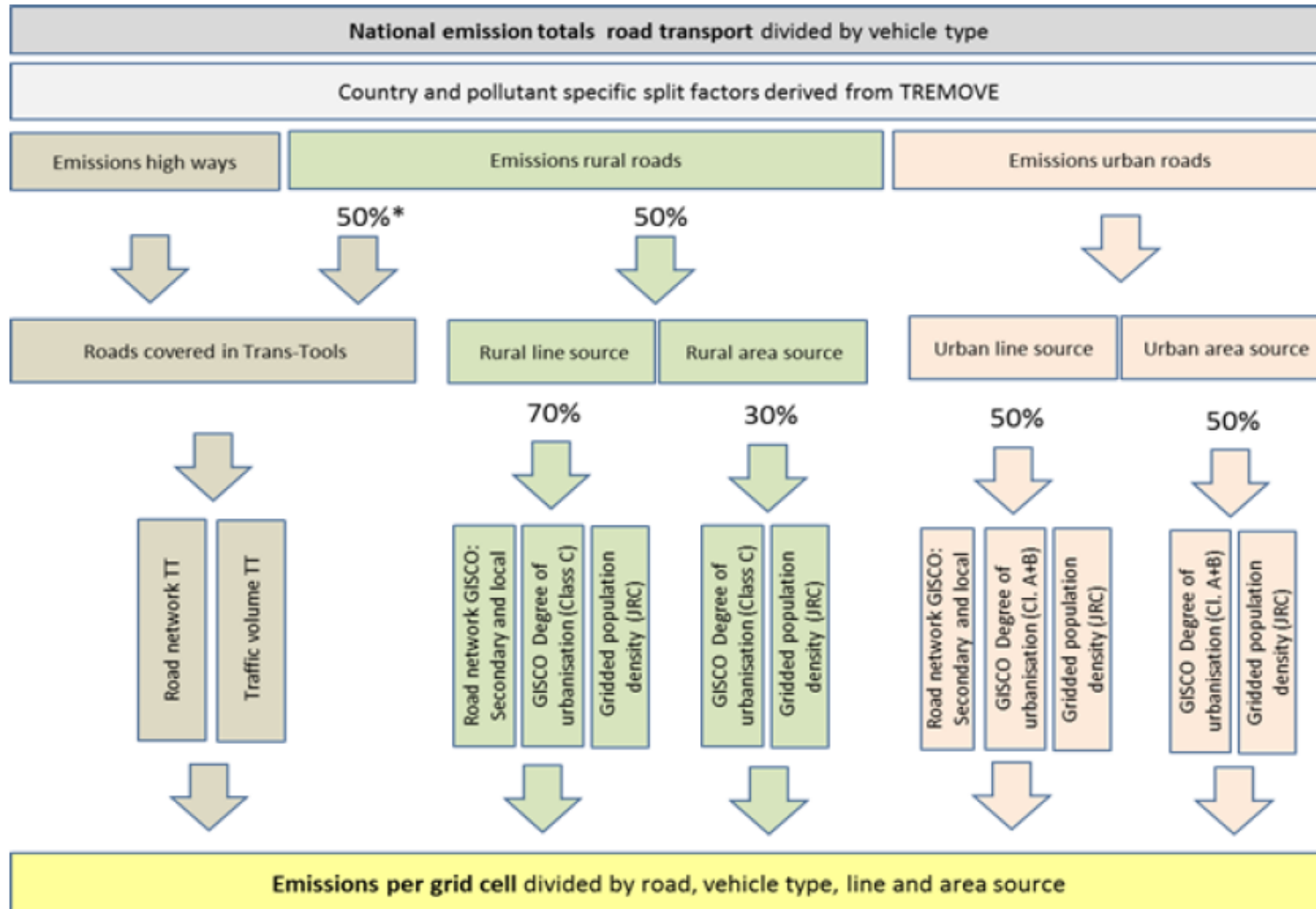
- Common issues
- Point sources emissions are inferior to a total GNFR sector. You have to split the rest of emissions as diffuse emissions.
- Point sources emissions are superior (!) to a total GNFR sector. In this case, it is better to solve the issue before implementing a complex solution.



- Emissions associated with a linear feature
- Lines cut by cells
- Emissions divided proportionally to the size of little lines



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* Trans-Tools covers major rural roads



- Diffuse emissions associated with a zone/ area (polygon features)
- Polygon cut by cells
- Emissions divided proportionally to the area size of sub polygons



- Administrative maps of cities / regions
 - Population census for these units
- Land cover maps
 - habitation zones / urban areas
 - Agricultural zones
 - Industrial zones
 - Zones with no supposed emissions
- Creation of zones manually : digitalization

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What does LPS mean?



Large Power
Stations

Large Point
Sources

Local
Pollution
Source

The total of LPS emissions is supposed to be the same as the total of the EMEP gridded emissions?



Yes No

What is the size of the EMEP grid cells?



50km*50km

0,1° * 0,1°

100m*100m

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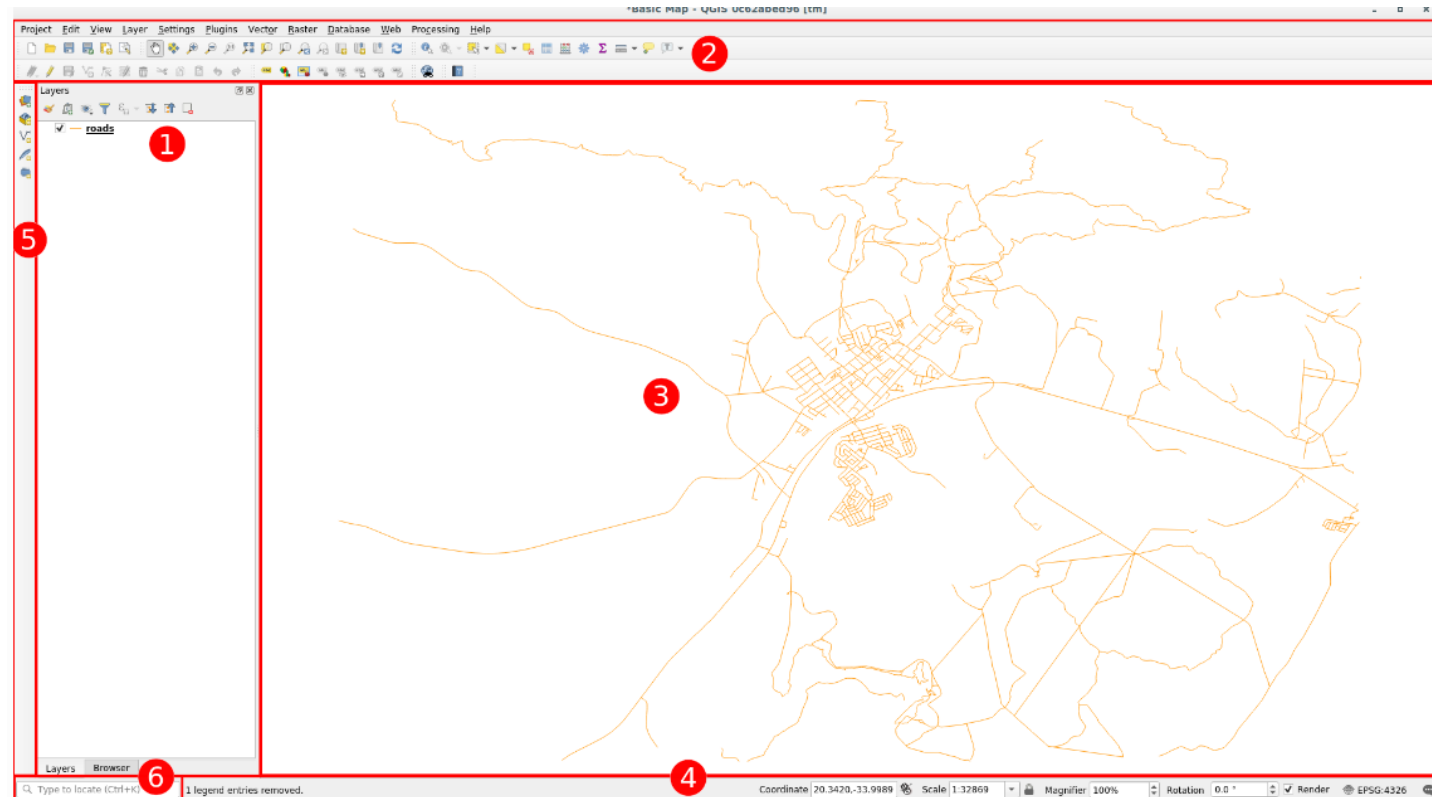
Introduction on QGis

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Practical demonstration





Download QGIS for your platform

Binary packages (installers) are available from this page.

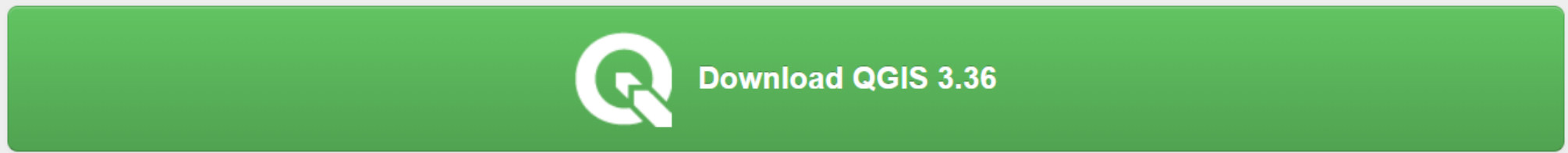
The current version is QGIS 3.36.0 'Maidenhead' and was released on 23.02.2024.

The long-term repositories currently offer QGIS 3.34.4 'Prizren'.

QGIS is available on Windows, macOS, Linux, Android and iOS.

- INSTALLATION DOWNLOADS**
- [ALL RELEASES](#)
- [SOURCES](#)

Download for Windows



Looking for the most stable version? [Get QGIS 3.34 LTR](#)

Frequent issues

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Frequent difficulties

- No spatial data
- Difficulty with « dirty » datasets
- Level of precision to choose for all subsectors
- «Remaining» emissions after using point sources
- inventory sources vs spatial sites
- Inventory not precise enough to prepare spatialization
- No time for spatialization
- Skills required for GIS use



Possible solutions

- Anticipate spatialization from the beginning of inventory process
 - Export of calculation in GNFR... in subsectors specifically disaggregated for spatialization purposed
 - Spatialiation files ready with clear distinctions between sites and sources
- Geospatial database ready



Inventory sources vs sites

- For each sector of the inventory, you can distinguish between different sources, for which you may calculate emissions differently. But on the map, your data (GIS layers) contains different objects.
- Case 1:
 - Several spatial objects but only 1 source.
- Case 2:
 - Some spatial objects do not appear in the inventory... do they have to be used for the gridded emissions ?

What are the types of geographical objects to map emissions ?

- Lines
- Points
- Areas
- All of the above



Layers are always saved in QGis, there is no need to save them as files



Yes

No

What will be the most useful function of QGIS that we will use



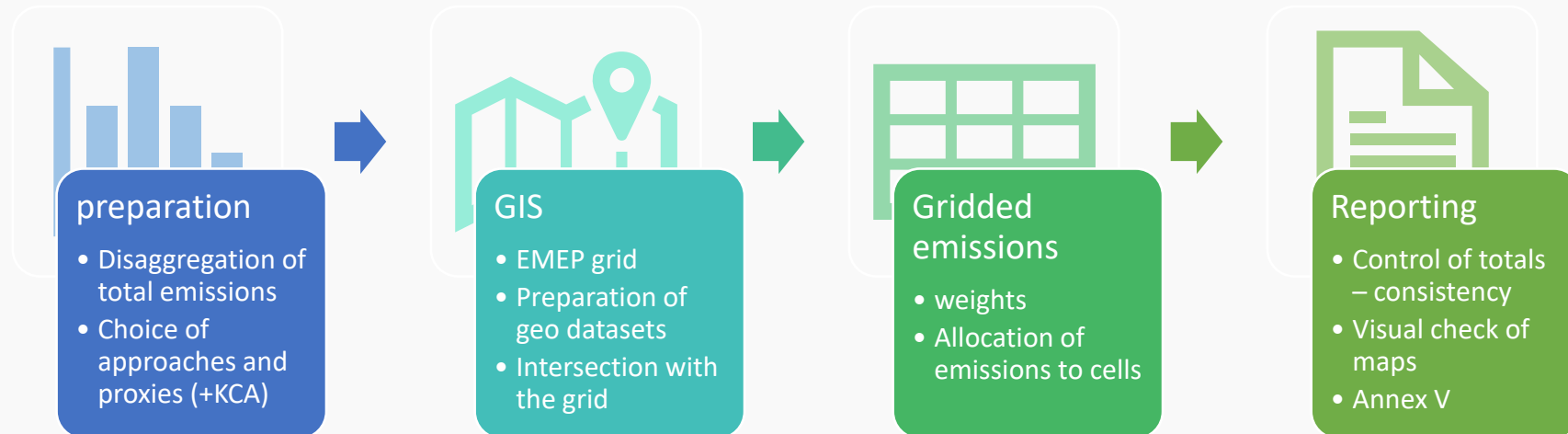
Buffering

Intersecting

Rasterizing

Workshop preliminary programme

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Action Plan



- Key categories will have to be gridded with the most accurate methods

Choice of method for each sector						
GNFR Sector	NFR code	Subsector	emissio	K C ?	method	dataset
A_PublicPower	1A1a	Public electricity and heat production	E	Yes		
B_Industry	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	E?	Yes		
B_Industry	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	E			
B_Industry	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	E	Yes		
F_RoadTransport	1A3bi	Road transport: Passenger cars	E	Yes		
F_RoadTransport	1A3bii	Road transport: Light duty vehicles	E			
F_RoadTransport	1A3biii	Road transport: Heavy duty vehicles and buses	E	Yes		
F_RoadTransport	1A3biv	Road transport: Mopeds & motorcycles	E			
F_RoadTransport	1A3bv	Road transport: Gasoline evaporation	E	Yes		
F_RoadTransport	1A3bvi	Road transport: Automobile tyre and brake wear	E			
F_RoadTransport	1A3bvii	Road transport: Automobile road abrasion	E			
I_Offroad	1A3c	Railways	E			
G_Shipping	1A3dii	National navigation (shipping)	E			
C_OtherStationaryComb	1A4ai	Commercial/institutional: Stationary	E	Yes		
C_OtherStationaryComb	1A4bi	Residential: Stationary	E	Yes		



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Sectoral emissions mapping and workshop will be organized by type of spatial disaggregation:

- **Point sites**
- **Linear emissions**
- **Area**



Thank you for your attention !

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