CEIP umweltbundesamt

Reporting of gridded data – basic approaches for spatial disaggregation

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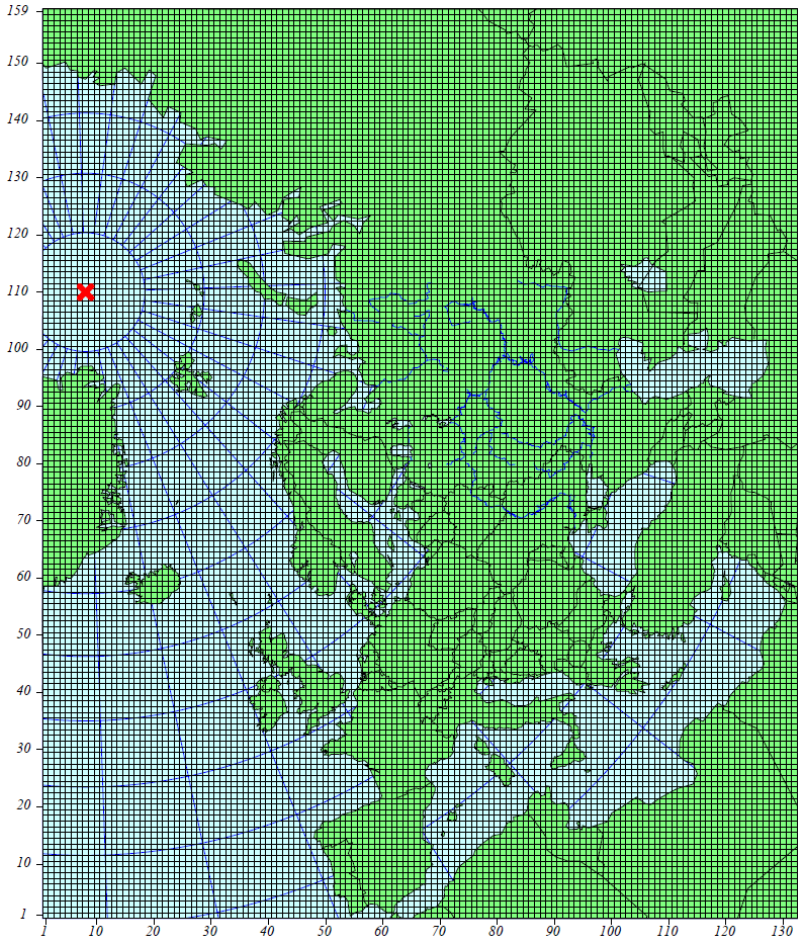
Reporting of gridded data to EMEP

- Gridded- and LPS data reporting is part of the five year reporting obligation.
- 2012 is a reporting year for gridded and LPS data
- Gridded data and LPS data in GNFR sectors (see reporting templates „Table IV 3A“ and „Table IV 3B“)
  → http://www.ceip.at/fileadmin/inhalte/emep/xls/AnnexIV_Reporting_templates_300909.xls
- See „EMEP/EEA air pollutant emission inventory guidebook 2009“ (Chapter 7 - Spatial Emissions Mapping)
  → http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009/part-a-general-guidance-chapters/7-spatial-emissions-mapping.pdf

Present EMEP grid



- Polar stereographic projection
- Grid resolution: 50 x 50 km²
  - Number of grid cells: ~ 21000
  - Size of a cell
    at 40°N (Italy): ~40 x 40 km²
    at 60°N (Scandinavia): ~50 x 50 km²
- Until 2008: 10 SNAP sectors + NT
- Since 2009: 18 GNFR sectors
- Pollutants: NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, CO, Pb, Cd, Hg, PCDD/PCDF, PAHs, HCB, HCH, PCBs

Discussed further modifications to the EMEP grid

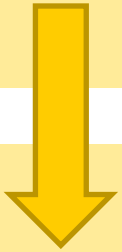
- Change of the grid projection from the current polar-stereographic (PS) grid to geographical coordinates (latitude-longitude grid)
- Increase of the grid resolution (0.1° x 0.1° or even less)
- Optional: Reduce only grid size and keep PS projection (10 x 10 km² or 5 x 5 km²)
- Aggregation of some GNFR sectors

SNAP Sectors and new GNFR Sectors

NFR02 (Level 1) → Reported Grid- and LPS data

01 - Combustion in Power Plants and Industry
02a - Transport above 1000m
02b - Transport below 1000m
03 - Commercial, Residential and Other Stationary Combustion
04 - Fugitive Emissions From Fuels
05 - Industrial Processes
06 - Solvent and Other Product Use
07 - Agriculture
08 - Waste
S9 - Other (included in National Total)

Conversion



SNAP Sectors → Used for gridding

S1 - Combustion in energy and transformation industries
S2 - Non-industrial combustion plants
S3 - Combustion in manufacturing industry
S4 - Production processes
S5 - Extraction and distribution of fossil fuels and geothermal energy
S6 - Solvent use and other product use
S7 - Road transport
S8 - Other mobile sources and machinery
S9 - Waste treatment and disposal
S10 - Agriculture
S11 - Other sources and sinks

GNFR Sectors → NEW

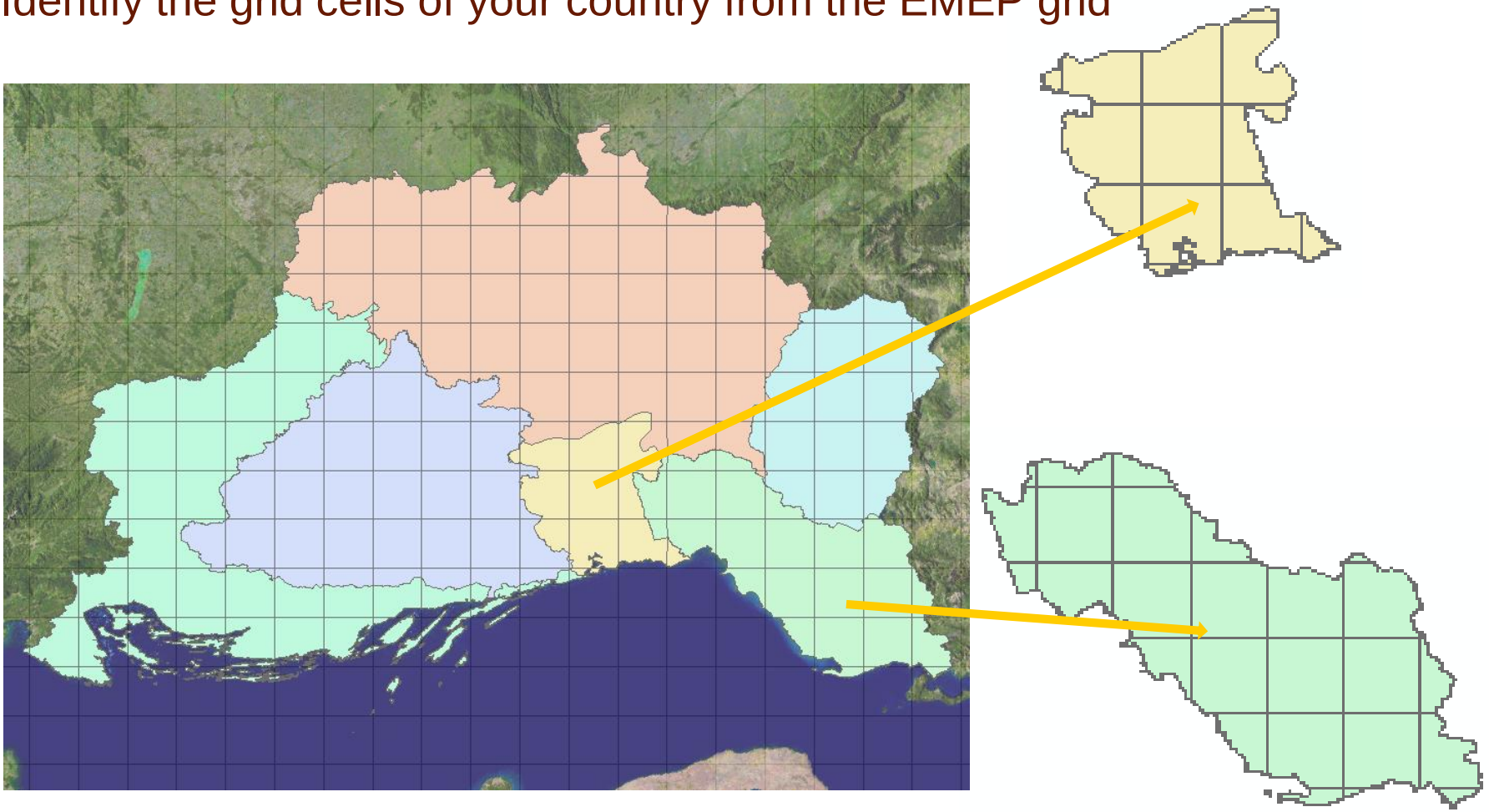
A_PublicPower
B_IndustrialComb
C_SmallComb
D_IndProcess
E_Fugitive
F_Solvents
G_RoadRail
H_Shipping
I_OffRoadMob
J_AviLTO
K_CivilAviCruise
L_OtherWasteDisp
M_WasteWater
N_WasteIncin
O_AgriLivestock
P_AgriOther
Q_AgriWastes
R_Other
S_Natural
T_IntAviCruise
z_Memo

Spatial disaggregation

- Step 1 → Identify the grid cells for your country from the EMEP grid
- Step 2 → Collect and prepare spatial proxy data to be able to allocate emissions to specific grid cells
- Step 3 → Calculate the fractions of each spatial proxy for all grid cells of your country
- Step 4 → Define which proxies should be used for the distribution of the individual sector emissions
- Step 5 → Distribute the sector total emissions regarding the spatial proxies for each pollutant and sector

Spatial disaggregation – Step 1

Identify the grid cells of your country from the EMEP grid



Data and Information to the EMEP grid

- At http://www.emep.int you can find information and data related to the EMEP grid
  - A map of the 50 km grid used between 1997 and 2008 (pdf format) and a map of the extended 50 km grid used until 2008 (eps format)
    → http://www.emep.int/grid/grid50.pdf and http://www.emep.int/grid/grid50_extended.eps
  - A text file containing the geographical coordinates and area of each grid cell
    → http://www.emep.int/grid/EMEPgrid.txt.zip
  - An interactive program to convert long/lat coordinates to EMEP grid cells and vice versa
  - A text file defining the fraction of grid cells (in percent) for each country in the EMEP domain
    → http://www.emep.int/grid/emep50official_country_grid_fraction.txt
  - A text file linking EMEP ISO codes to EMEP country/area codes and country/area names
    → http://www.emep.int/grid/country_numbers.txt
  - ESRI shape files for each country with 50 km grid polygons are available at CEIP

Spatial disaggregation – Step 2

Collect and prepare spatial proxy data to be able to allocate emissions to specific grid cells

- LPS (e.g. from E-PRTR)
- Commercial and industrial units (e.g. CORINE land cover – CLC)
- Urban areas (e.g. ESA GlobCover land cover map)
- Population (e.g. SEDAC GPWv3)
- Gas distribution network
- Motorways and roads (e.g. Open street maps, digital chart of the world, TREMOVE, etc.)
- Rail network
- Agricultural areas (e.g. CLC)
- Animal stocks (e.g. EUROSTAT)
- National shipping
- etc.

National datasets

- From national statistical centres, such as demographic, economic, transport, regulatory, energy, regulating bodies and trade associations, e.g.

  - Population and employment
  - Gas distribution networks
  - Agricultural data
  - Road network information
  - Rail network information
  - Airport activity data
  - Aviation
  - National shipping
  - Point source information
  - Local inventory data

International datasets

- There are a number of different international datasets that can be used to derive spatial proxy data

  - INSPIRE (http://www.inspire-geoportal.eu)
  - EDGAR (http://edgar.jrc.ec.europa.eu)
  - APMOSPHERE (http://www.apmosphere.org)
  - CORINE (http://www.eea.europa.eu/data-and-maps/data)
  - ESA GlobCover (http://ionia1.esrin.esa.int)
  - ICAO (http://www.icaodata.com)
  - Eurostat (http://ec.europa.eu/eurostat/ramon)
  - Lloyds Register (http://www.lr.org)

Spatial disaggregation – Step 3

Calculate the fractions of each spatial proxy for all grid cells of your country

Id	Emep (i)	Emep (j)	Proxy A	Proxy B	Proxy C	...
1	87	45	0.3	0.5	0	...
2	87	46	0.1	0	0	...
3	88	44	0.1	0	0	...
4	88	45	0.2	0.4	1	...
5	88	46	0.1	0	0	...
6	89	43	0.2	0.1	0	...
...	...	...	...	...	...	...

E.g. Proxy A = Population, Proxy B = CLC Industrial Units, Proxy C = CLC Urban Areas, etc.

Converting proxy data to EMEP grid cells

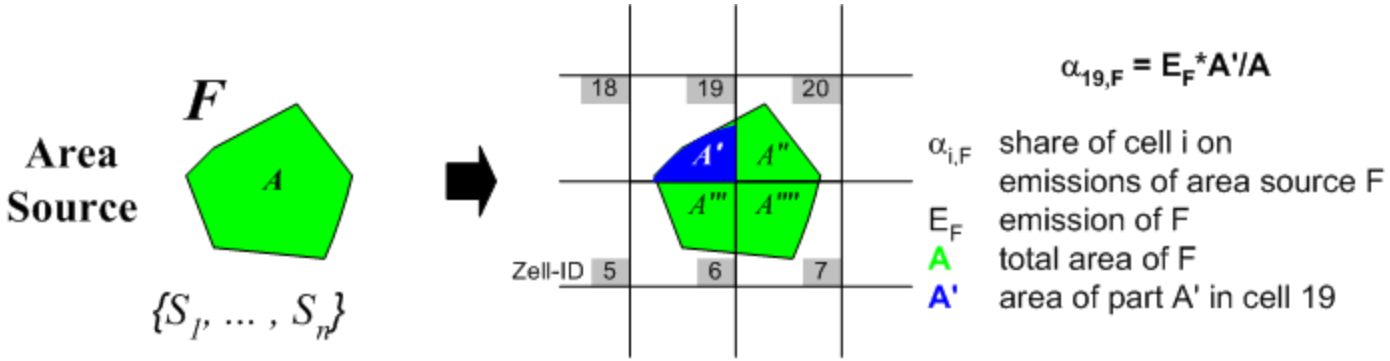
- This is generally done by resolving the different spatial forms from a proxy map to the EMEP grid cells

- Spatial forms can be
  - Area sources (urban areas, agricultural areas, etc)
  - Line sources (streets, railways, rivers, etc.)
  - and Point sources (power plants, industrial plants, etc.)

- For a line and area conversion to grids GIS software is needed, where spatial intersect operations (between the proxy layer and the EMEP grid layer) can be executed (e.g. ArcGIS, GRASS GIS, etc.)

Area sources (polygons) to grids

- Intersecting a polygon with the EMEP grid will produce individual polygons for each grid cell

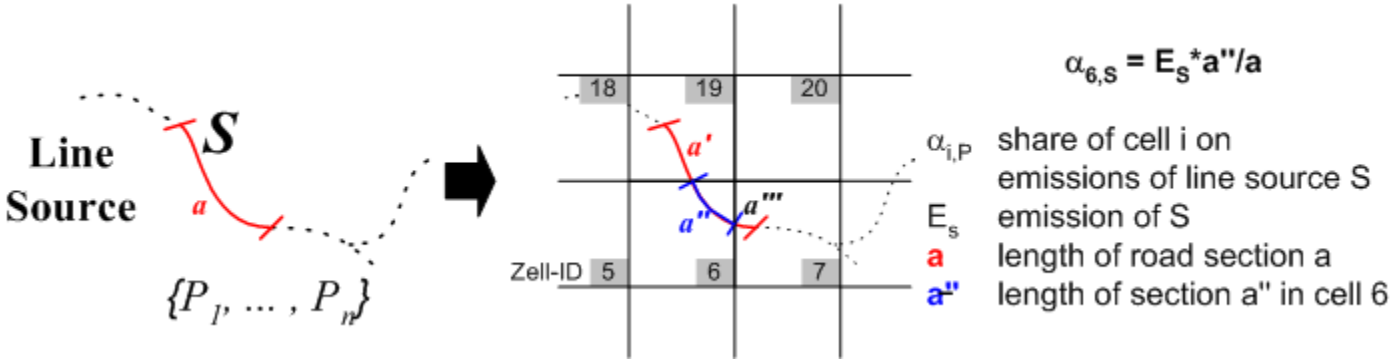


- The fraction of the area of the new polygons can be used to distribute the source (e.g. agricultural area) to the grid cells.

- With this information you can calculate the fractions of each grid cell for the emission distribution

Line sources to grids

- Intersecting a line feature with the EMEP grid will produce shorter separated lines for each grid cell

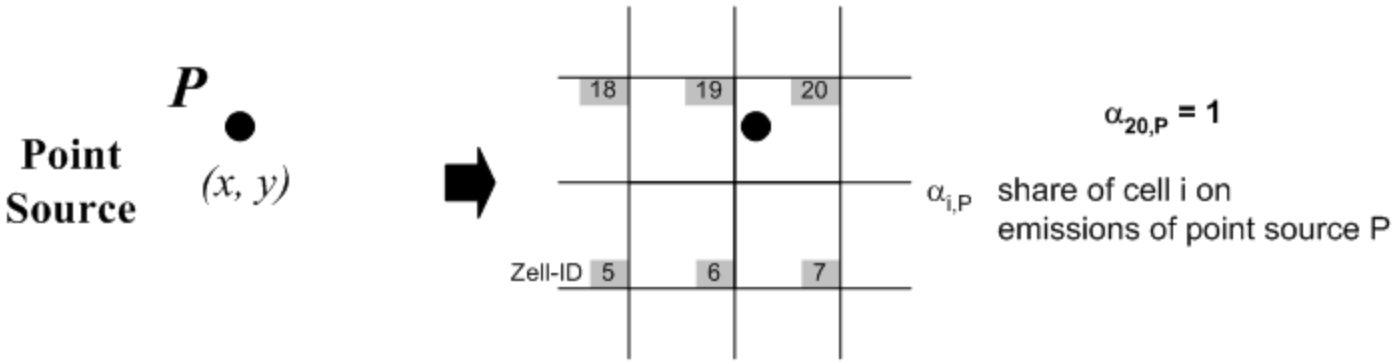


- The fraction of the new lines can be used to distribute the source (e.g. Street) to the grid cells.

- With this information you can calculate the fractions of each grid cell for the emission distribution

Point sources to grids

- Point sources can be allocated directly to the grid within which they are contained by converting the coordinates of the source (usually long/lat information) to EMEP grid cells or by intersecting the point with the EMEP grid



- An interactive program to convert long/lat coordinates to EMEP grid cells (and vice versa) is available at http://www.emep.int/grid.

- Here you can find also a Fortran library for the coordinate conversion and a documentation.

Converting between different spatial projections

- In a number of cases you may need to combine different spatial datasets with different spatial projections (e.g. WGS84 and EMEP PS projection)

- Most GIS software (e.g. ESRI ArcGIS) can convert the geographic coordinate system to any projected coordinate system (like EMEP PS) and vice versa

- The Open Geospatial Consortium Inc. provides guidance and standards for coordinate transformation (http://www.opengeospatial.org/standards/ct)

Spatial disaggregation – Step 4

Define which proxies should be used for the distribution of the individual sector emissions

Sector	Proxy 1	Proxy 2	Proxy 3
B_Industrial Combustion	E-PRTR	CLC (commercial and industrial units)	CLC (urban areas)
C_Small Combustion	Population (GWPv3)	-	-
G_RoadRail	TREMOVE	Open street maps and Digital charts of the world (motorways, roads)	CLC (urban areas)
O_Agri Livestock	CLC (agricultural areas, pasture)	EUROSTAT (animal stocks)	

Spatial disaggregation – Step 5

Distribute the sector total emissions regarding the spatial proxies for each pollutant and sector

- If you have more than one spatial proxies allocated to a sector you can
  - define a weighting for each proxy and calculate an overall grid cell distribution
  - or split the sector emission (e.g. on NFR level) and distribute each part with a different spatial proxy

- If you want to allocate LPS emissions directly to the EMEP grid you have to subtract this emissions from the sector total emissions you distribute with the proxies

Basic principle of distributing emissions

NOx emission from C_SmallComb in cell i

$$emission_{ix} = emission_t \times \frac{value_{ix}}{\sum_{jx} value}$$

Population in cell i

Population of the whole area/country

Where:

i : is a specific geographic feature; (grid cell)

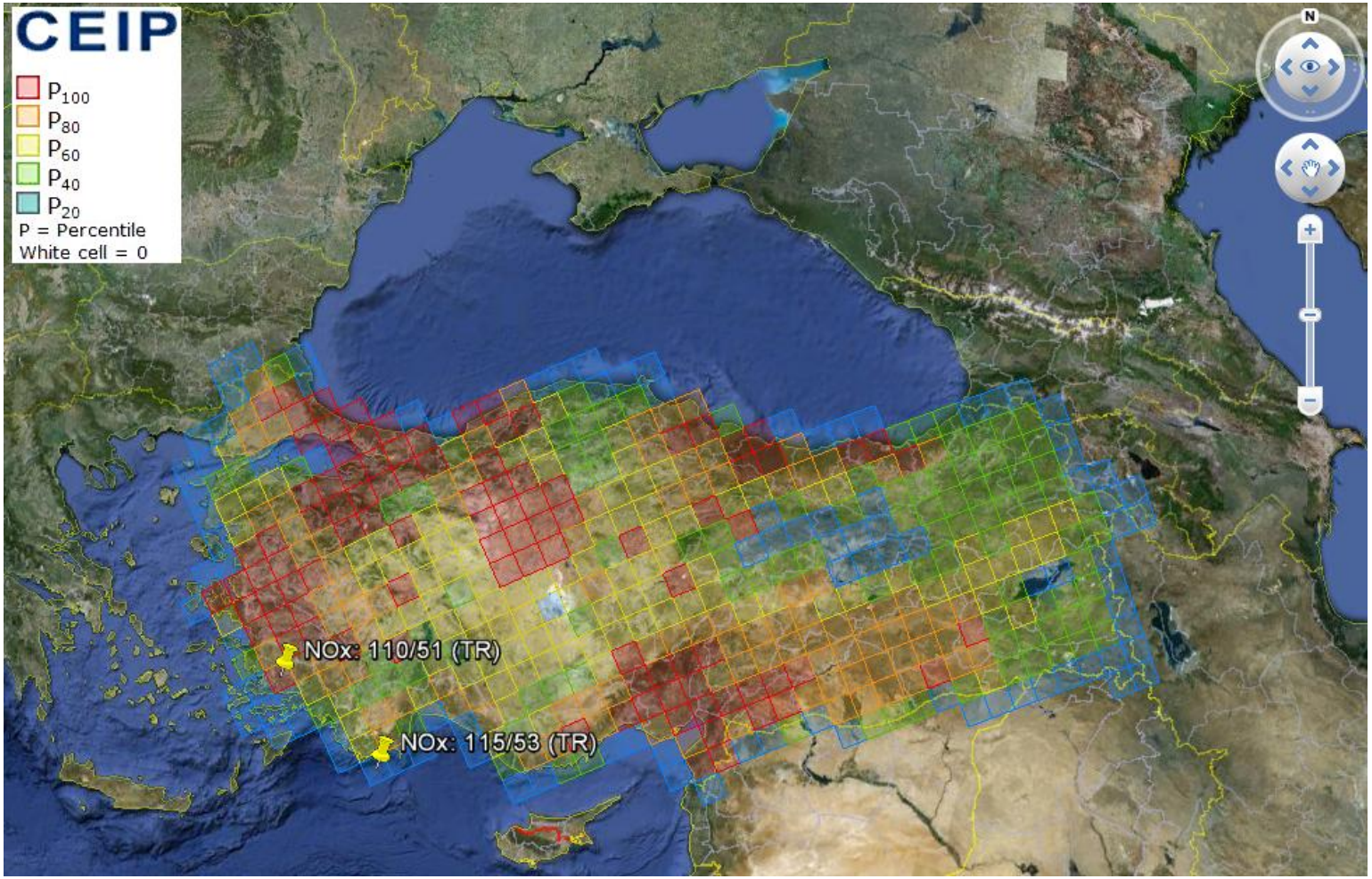
$emission_{ix}$: is the emissions attributed to a specific geographical feature (e.g. a grid, line, point or administrative boundary) within the spatial surrogate dataset x;

x; (e.g. population)

$emission_t$: is the total national emission for a sector to be distributed across the national area using the (x) surrogate spatial dataset; (e.g. NOx emissions from C_SmallComb)

$value_{ix-jx}$: are the surrogate data values of each of the specific geographical features within the spatial surrogate dataset x.

Thank you very much for your attention



http://www.ceip.at