

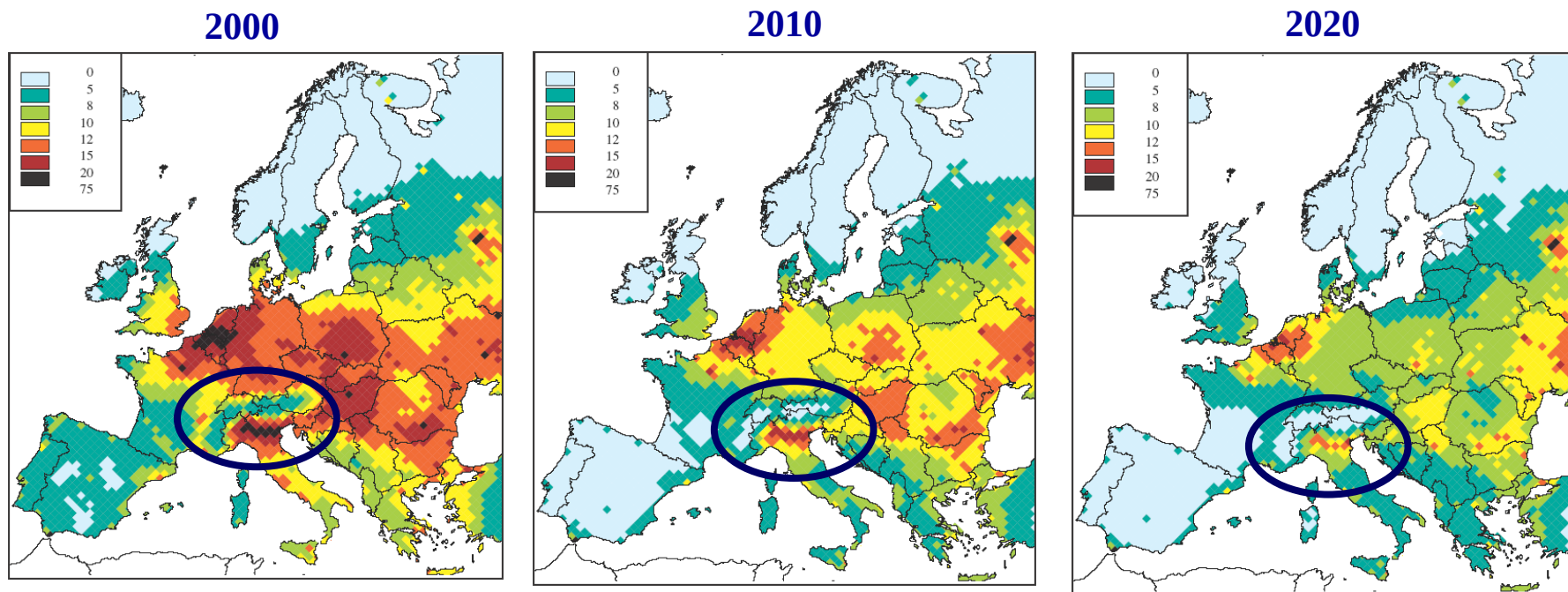
Preparation of a spatially resolved emission inventory as input for modeling in the Po Valley

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Emission Inventory Conference
Baltimore 14/04/2009

The Po Valley (together with the Benelux) has been identified as one of the EU areas where pollutants levels are critical, causing impacts on the public health. The area will remain problematic by 2020 despite the application of the current European legislation devoted to air pollution control. (Result of different scenarios carried out in the frame of the Clean Air for Europe programme by IIASA*).



Grid-averaged concentrations of the annual mean PM_{2.5} [$\mu\text{g}/\text{m}^3$] from known anthropogenic sources excluding secondary organic aerosols.

General characteristics of the Po valley:

- highly populated-industrialized area
- high density of emissions (traffic, ind. & non ind. Combustion, energy...)
- surrounded by mountain ridges
- poor ventilation



**high pollution levels and frequent thresholds violations
especially during winter**

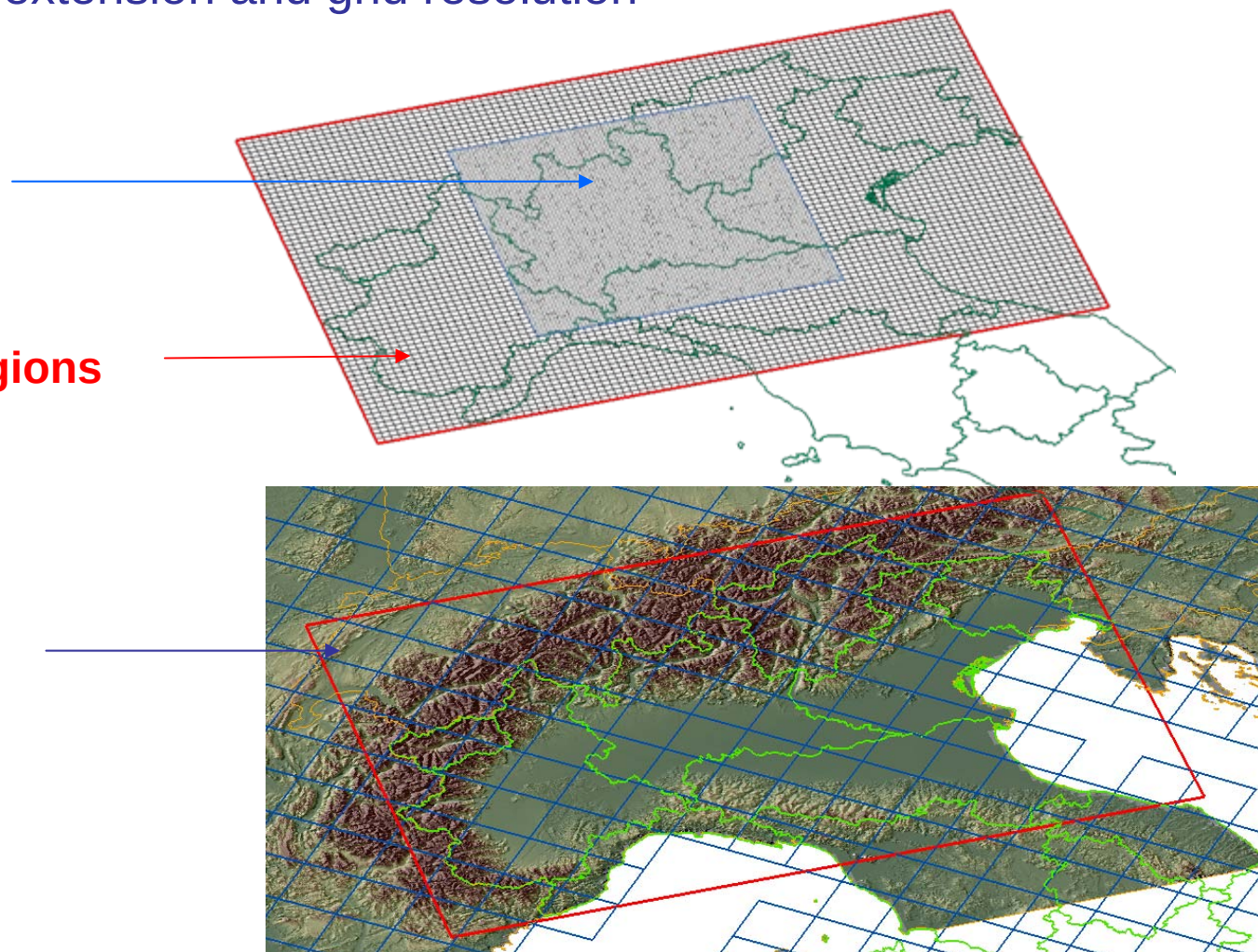
- Importance of local control measures to efficiently reduce air pollution.
- The Italian regions located in the Po Valley area have designed regional air quality plans which include a series of control measures with the aim to abate air pollution levels.
- A collaborative research project between the European Commission's Joint Research Centre and the Lombardy Region started: Integrated air quality assessment over Lombardy and the whole Po valley
- Objective: to analyze the effectiveness of the Regional emission abatement measures on air quality within the Po-Valley and Lombardy region for different time horizons (2010 → 2020).
- One of the Work Packages: air quality modeling intercomparison exercise (POMI)
- → **The application of advanced numerical air quality models (AQMs) over the Po Valley needs as input accurate and spatially distributed atmospheric emission inventories.**

Modeling domain: extension and grid resolution

Lombardy
(3km x 3km grid)

Other Po Valley regions
(6km x 6km grid)

Rest of the domain
(EMEP 50km x 50km)

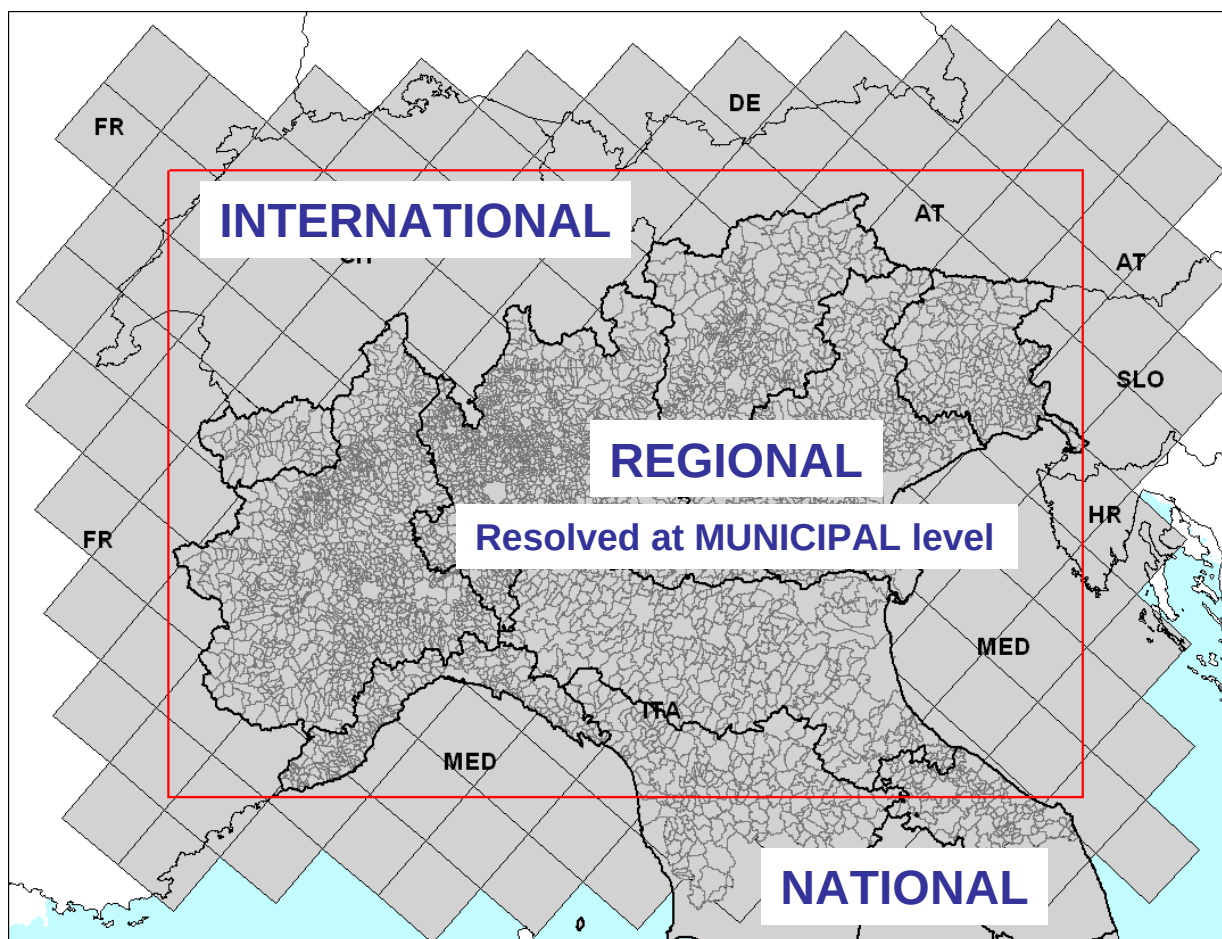


ROLE OF THE JRC (modeling WP)

Coordination and management of all the project activities

- Elaboration and preparation of the meteorological fields for modeling.
- **Elaboration and preparation of the emission inventories for modeling**
 - **Acquiring and combining all the available data from the institutions officially charged of the EI creation and maintenance**
- Coordination of the modeling activity
- Modeling intercomparison
- **Preparation of emission scenarios for modeling**

Emissions inventories for the Po Valley modeling domain can be collected at different spatial scales:



SPECIFIC ACTIVITIES

EMISSION DATA

- Acquisition/collection
- Homogenization
- Merge all the available data (different scales and different level of detail)
- Downscaling and spatial disaggregation (where necessary)
- Spatialization and gridding (3 x 3 km)

AUXILIARY DATA

Geographic dataset – proxies - ...

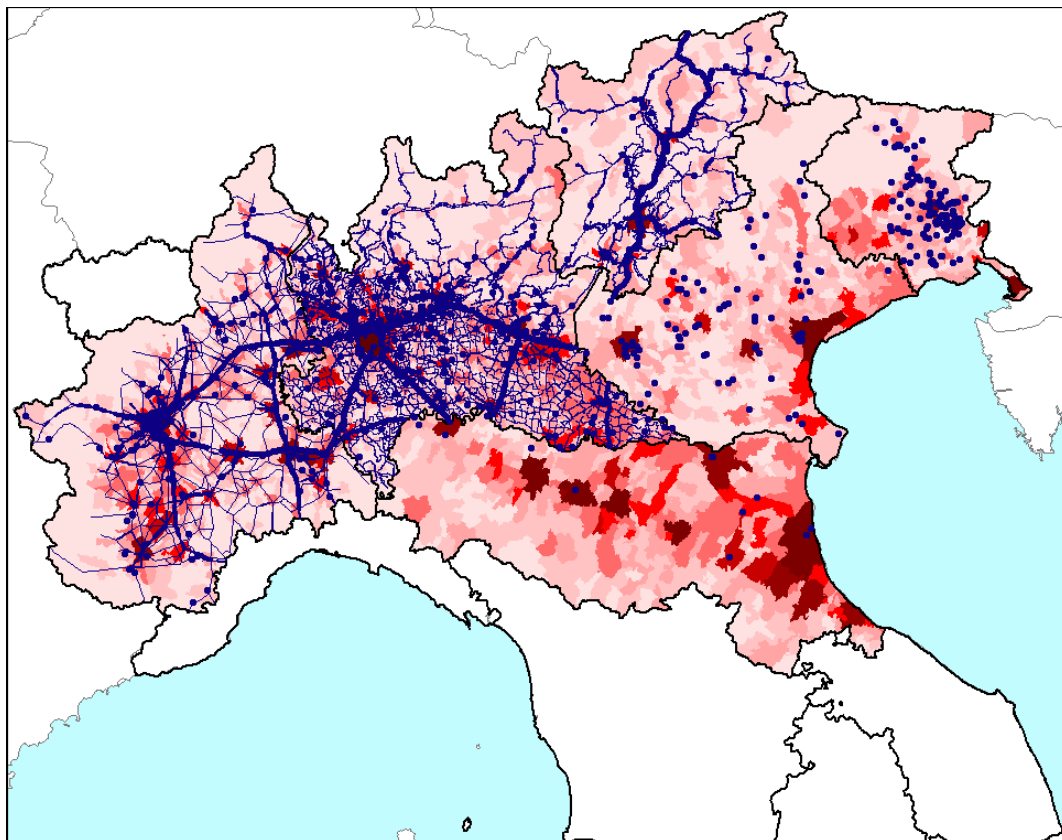
- Acquisition/collection
- Homogenization – Georeferencing new data
- Merge all the available data (different scales and resolution)

Regional emission inventories

INEMAR (INventario EMISSIONi ARia) - the DB estimates the emissions of several pollutants (SO₂, NO_x, COVNM, CH₄, CO, CO₂, N₂O, NH₃, PM_{2.5}, PM₁₀, PTS and others) for each emission activity and fuel type.

Created and maintained by the regional environmental protection agencies (ARPA)

- Calculated by municipality
- Point sources specified
- Mobile emissions: supported by traffic models (in some region)



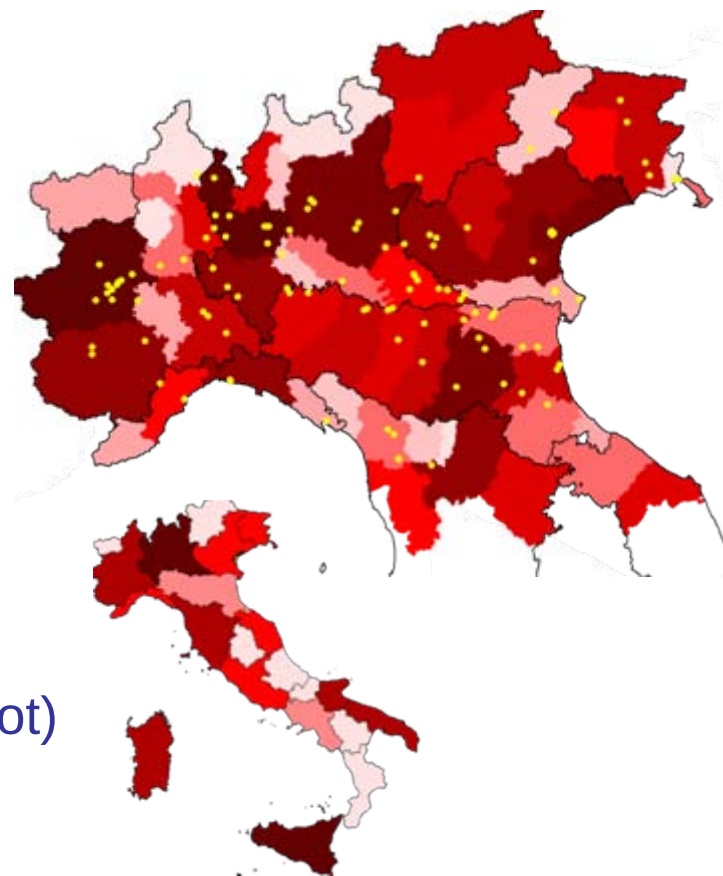
National emission inventory (Italy)

The DB collects all the emission estimates of the major pollutants including GHG (green house gases), ozone precursors, benzene, PM, HM (heavy metal) and PAH (polycyclic aromatic hydrocarbon).

Created and maintained by ISPRA, the Italian Institute for Environmental Protection and Research (ex APAT)

The inventory is reported to the European Commission at national aggregated level (NUTS0).

- Calculated at regional level
- Then disaggregated at the provincial level
- The main point sources are specified (200 tot)
- No emissions by road link

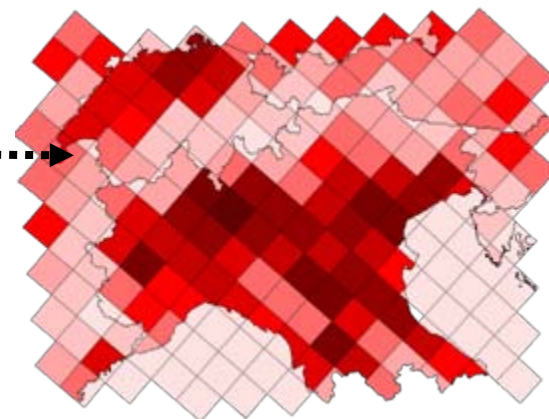
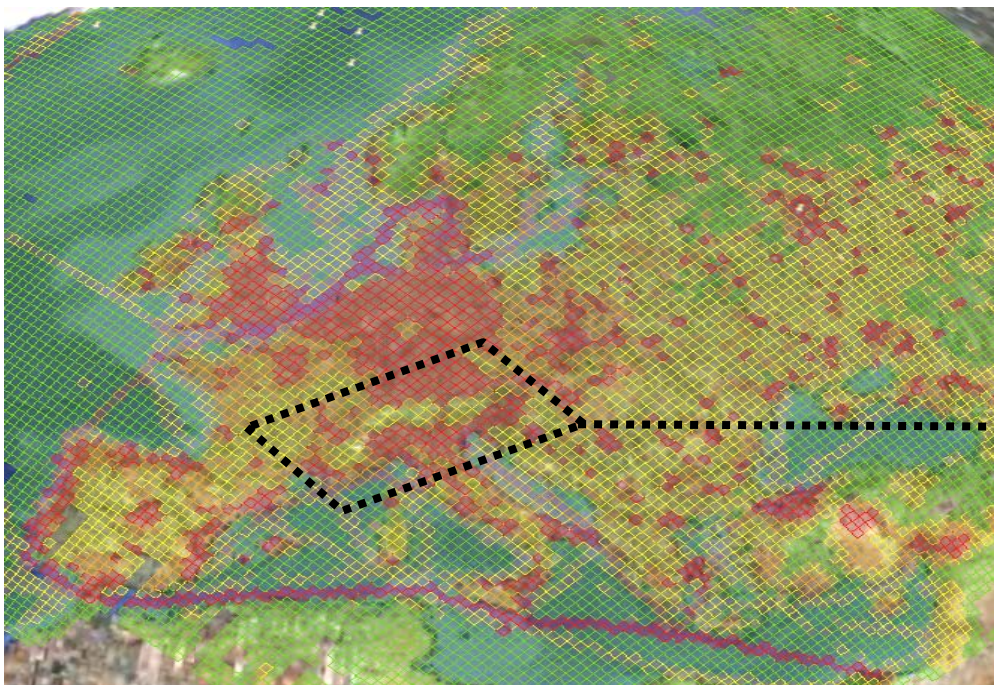


EUROPEAN emission inventory

UNECE/EMEP European emission database includes officially reported annual emissions of acidifying air pollutants, heavy metals, particulate matter and photochemical oxidants.

EMEP is the scientific program of the CLRTAP (Convention on Long-Range Trans-boundary Air Pollution) providing emissions for air quality modeling.

- Reported at national level
- Then gridded at 50 x 50 km
- No point sources (specified in EPER)
- No emissions by road link



BASIC ASSUMPTIONS

- In order to get the highest accuracy in the POMI emission inventory **absolute priority to the regional emission inventories** has been given.

Main assumption: the calculation of emissions done locally by the regions would be more suitable to capture local information, than a pure top-down disaggregation of the national emission inventory (in particular for some sector and activity).

- New opportunity to use locally calculated emission data supplied by several regions.

(Note: not all the INEMAR are currently 100% implemented).

- → Where regional information is missing on the domain it is substituted by data coming from the upper levels: national and EMEP emission inventories.
- Pollutants selected for modeling: SO₂, NO, NO₂, NH₃, VOC, CO, PM_{2.5}, PM₁₀, (PMCoarse)

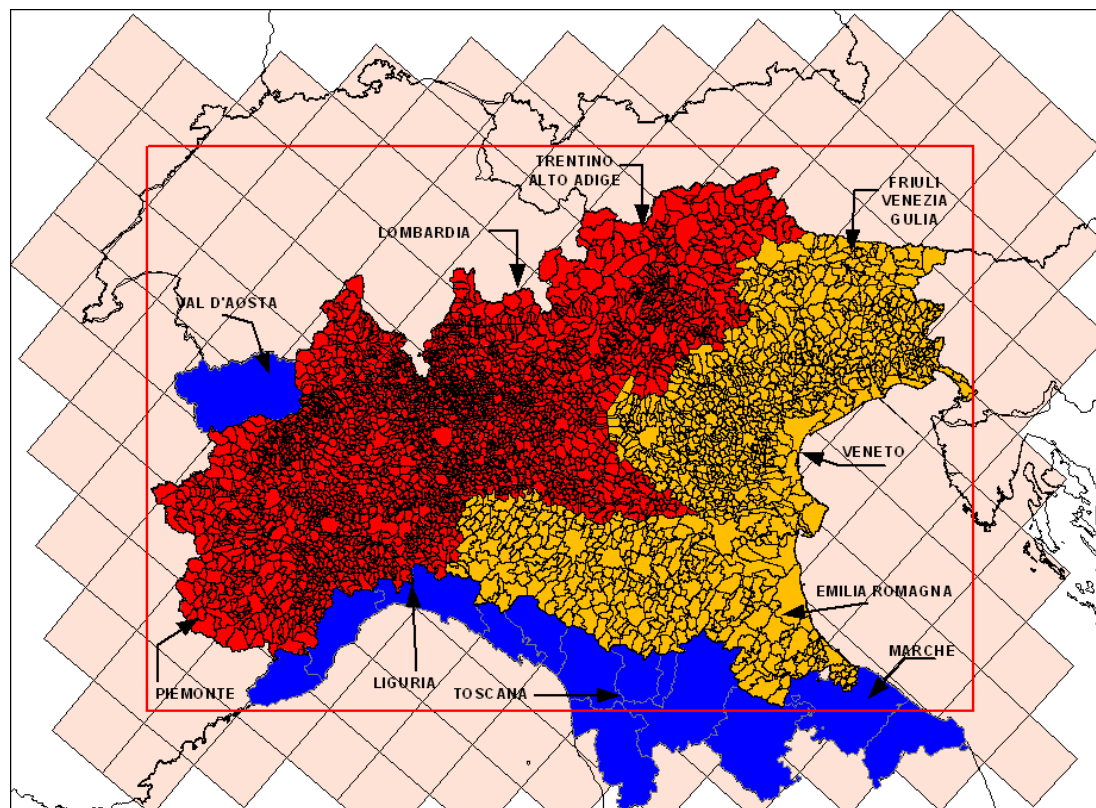
Degree of completeness of the local inventories in Italy (INEMAR)

Only three regions have delivered a fully completed INEMAR emission inventory

In the other regions of Po Valley the degree of implementation and completeness is different

In the “uncompleted” regions the inventories contain at least:

- point sources emissions:
Combustion in energy and transformation systems,
Production processes and
Combustion in manufacturing industry
- road transport emissions
- non industrial combustion
(biomass and wood combustion)



Compensation with national data

Compensation with EMEP at the boundaries

Availability of data by kind of source (geometry) and by region:

AVAILABILITY BY GEOMETRY OF EMISSION SOURCES	LOMBARDIA	PIEMONTE	VALLE D'AOSTA	TRENTINO ALTO ADIGE	VENETO	FRIULI VENEZIA GIULIA	LIGURIA	EMILIA ROMAGNA	TOSCANA	MARCHE	OUT OF ITALY AND SEA
DIFFUSIVE EMISSIONS	INEMAR	INEMAR	NATIONAL	INEMAR	NATIONAL + INEMAR	NATIONAL + INEMAR	NATIONAL	NATIONAL + INEMAR	NATIONAL	NATIONAL	EMEP
POINT SOURCES	INEMAR	INEMAR	NATIONAL (AS DIFFUSIVE)	INEMAR	INEMAR	INEMAR	NATIONAL (AS DIFFUSIVE)	INEMAR	NATIONAL (AS DIFFUSIVE)	NATIONAL (AS DIFFUSIVE)	INCLUDED IN THE DIFFUSIVE
LINE SOURCES	INEMAR (With road transport model)	INEMAR (With road transport model)	NATIONAL (Without road transport model)	INEMAR (With road transport model)	INEMAR (Without road transport model)	INEMAR (Without road transport model)	NATIONAL (Without road transport model)	INEMAR (Without road transport model)	NATIONAL (Without road transport model)	NATIONAL (Without road transport model)	INCLUDED IN THE DIFFUSIVE

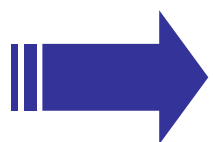
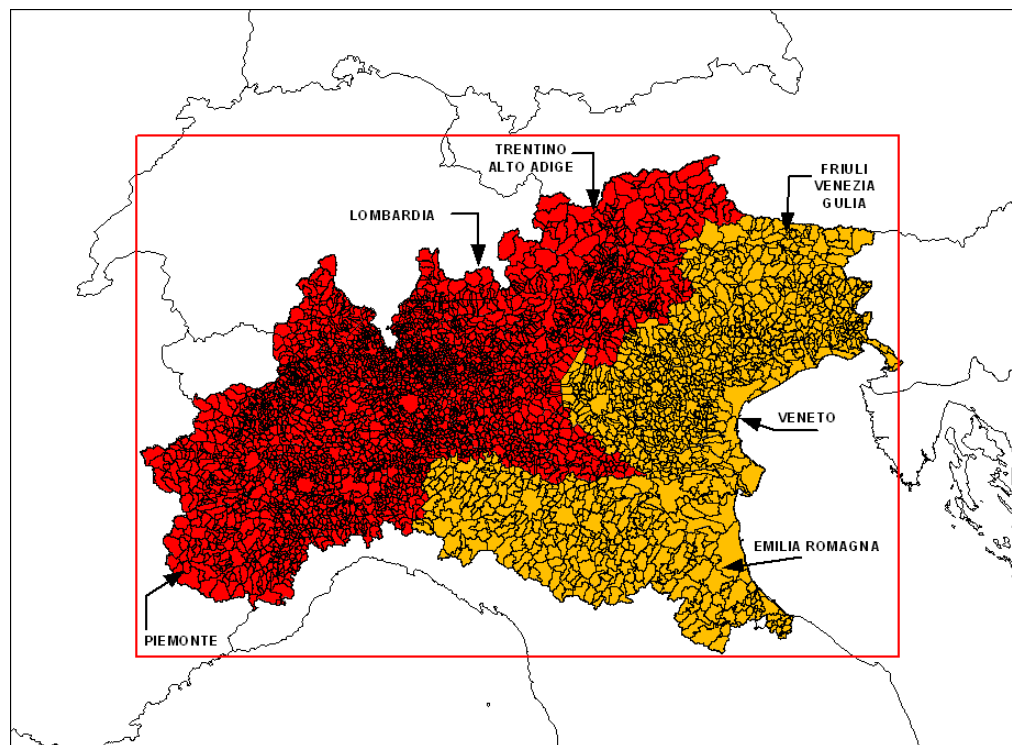
Homogenization of local emission data: some difficulties

- Different file structures and formats (mix of MS Excel and MS Access files)
- Sometime non homogeneous use of pollutant names
- Not all pollutants covered by all the regions (e.g. PM10/PM2.5)
- COPERT IV not applied in two regions for mobile sources emissions
- Corrections done to some of the original database
- ...

How much of the total Po Valley emissions we get from the available local inventories?

The proportions of emission reported locally with respect to the total Po Valley emissions are:

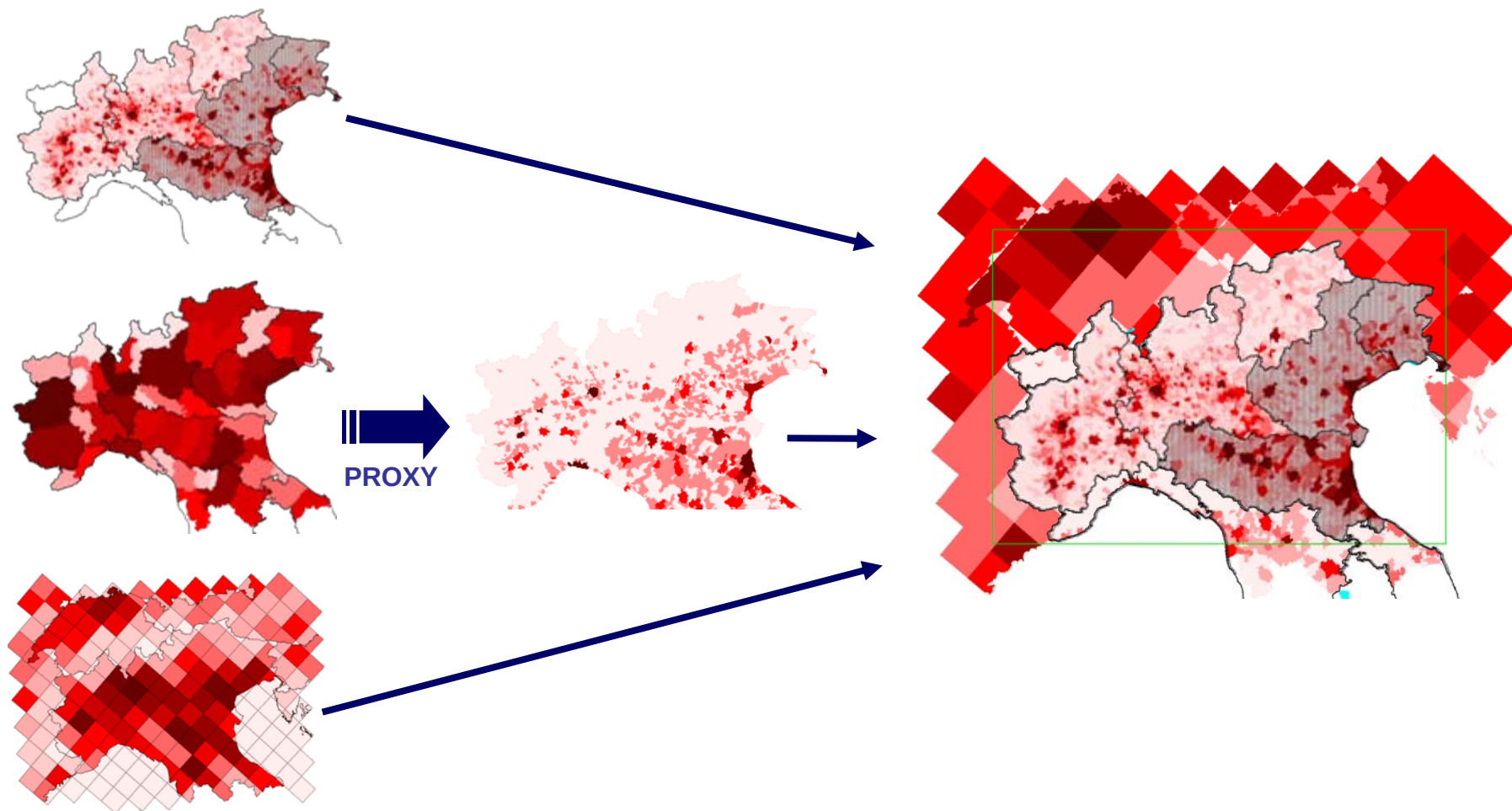
- SO₂: 45%
- NO_x: 80%
- CO: 88%
- COV: 36%
- PM: 65%



despite the incompleteness of local inventories in some regions, a large proportion of the total emissions of the domain is covered by local inventories.

Main Steps for the combination of the emission datasets

DIFFUSIVE sources emissions

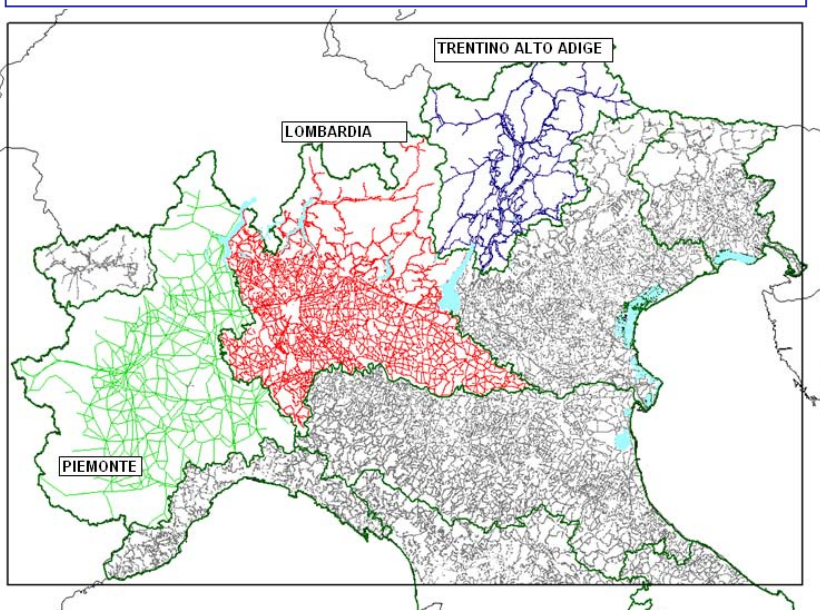


- Number of operators and personnel employed in productive and commercial activities per municipality (Source: ISTAT – ASIA database 2005 and census of productive and commercial activities - 2001)
- Resident people (Source: ISTAT – GEOdemo database 2005 - provinces and municipalities)
- Number of buildings (Source: ISTAT general population census - 2001)
- Harbors and seaports of Italy: no homogeneous and complete source was available in digital format. A complete list, classification and map of the harbors has been created taking as reference the official classification^[1] of the Italian commercial harbors. Touristic harbors have been added to each municipality according to the guide “Pagine azzurre - The yachtsman's essential guide”
- Harbor traffic: ISTAT “Statistiche dei trasporti marittimi Anni 2002-2004”
- River network and lakes: regional layers (regional geographic information systems offices)
- Airports traffic: ISTAT “Statistiche del trasporto aereo Anni 2004-2005”
- Off-road agricultural machineries per municipality: ISTAT – Agriculture census 2000.
- Cattle breeding, poultry farms and all the livestock holding: ISTAT – Agriculture census 2000.
- Waste management, landfills or waste combustion: APAT - Rapporto rifiuti 2006.
- For all land-uses: CORINE Land Cover 2000 spatial dataset (source: European Environmental Agency)
- Spatial dataset of railways and road networks: highways, national, provincial and municipal roads (source: Teleatlas and regional geographic information systems offices)
- Traffic flow on Italian highways: AISCAT – Statistiche autostradali 2005
- 2005 vehicle fleet at municipal level (source: ACI dataset and elaborated by the JRC)
- Methane distribution network (source: Platts, A Division of The McGraw-Hill Companies)
- Climatic classification of municipalities (source: ENEA and DPR n.412 1993)
- Digital Elevation Model of the Po Valley area for the altimetry classification of the municipalities (Source: NASA SRTM)

Main Steps for the combination of the emission datasets

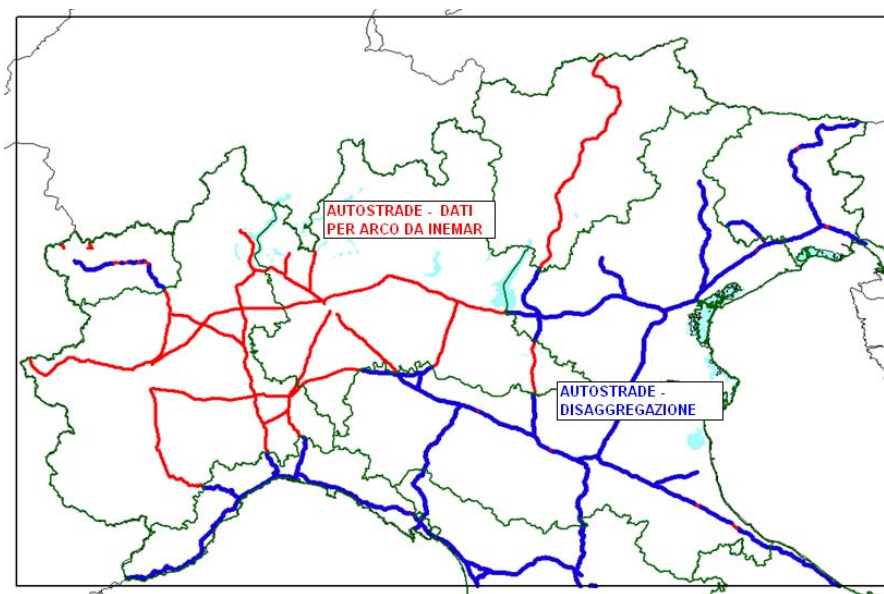
LINE sources emissions (Road traffic)

Regions with road transport model



Emissions estimated on each road link
on the basis of traffic information

Regions without road transport model



Emissions estimated by municipality
Spatialization by GIS on the basis of the
road network, highway traffic and car fleets

Main Steps for the combination of the emission datasets

POINT sources emissions

- Homogenization of stacks data and parameters (where possible) - Parameterization of some stack characteristics
- All point sources of PO Valley reported locally were merged in a unique database
- Reclassification of point sources in three categories according to the completeness of the records (availability of geographic coordinates, stack parameters etc.)
- Fixing the coordinates

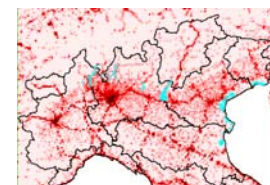
1. Point sources INEMAR (> 1000)

As points



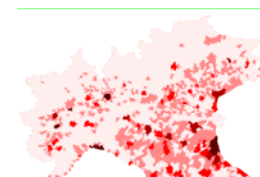
2. Point as diffusive with coordinates (small sources or missing stack parameters) - INEMAR + APAT (≈100 of 200)

Level of grid cell



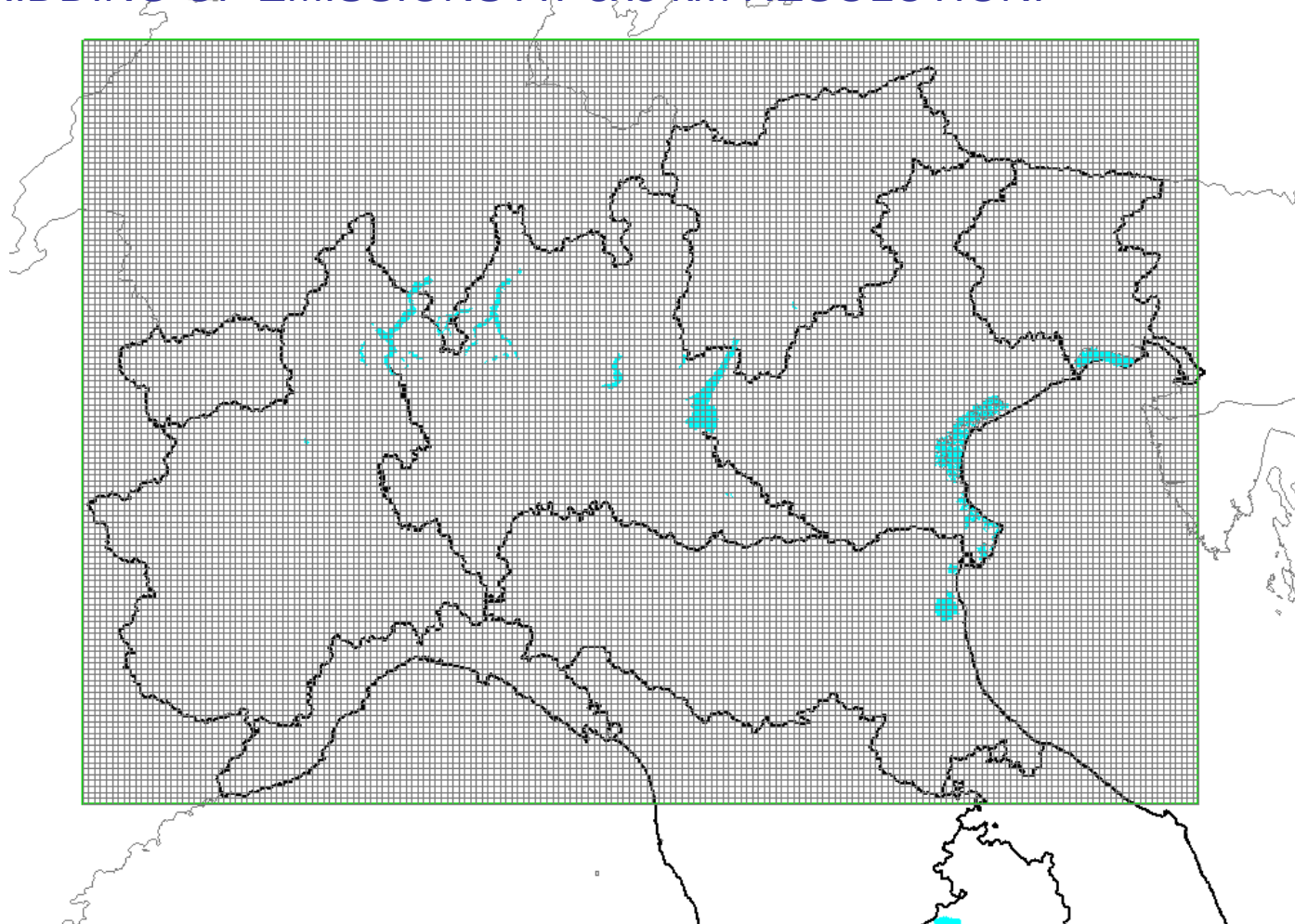
3. Point as diffusive (without coordinates) → INEMAR

Level of municip.



GRIDDING OF THE POMI EMISSION INVENTORY

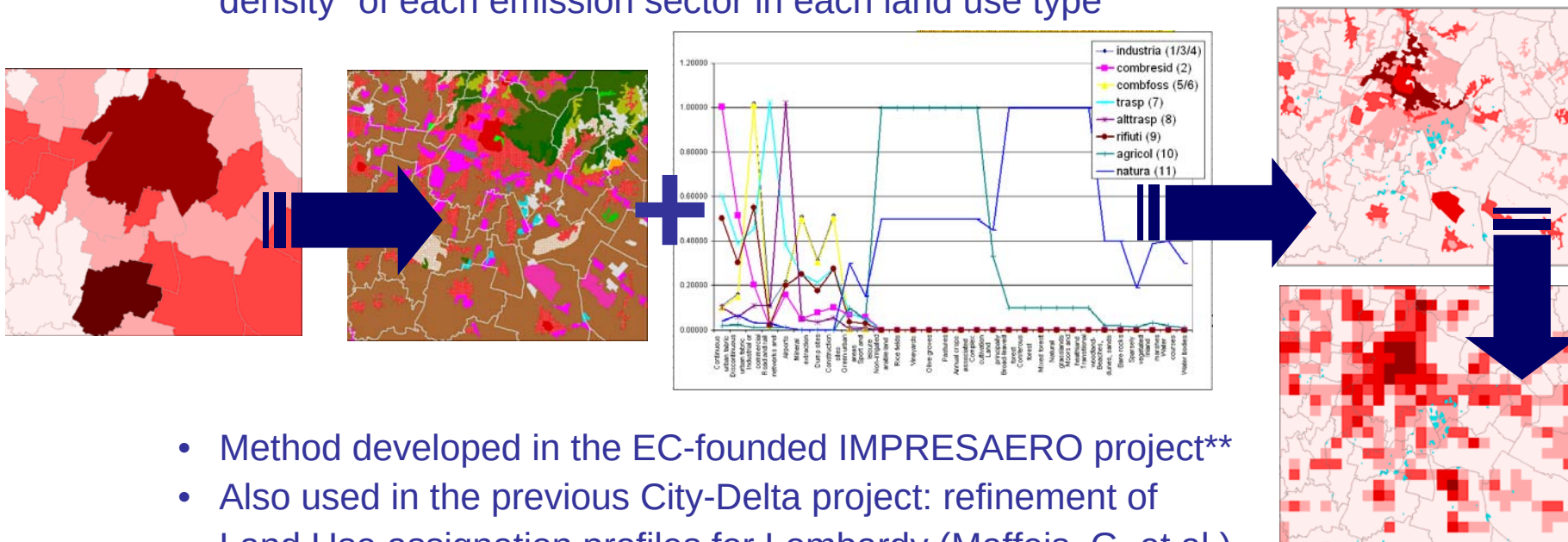
– GRIDDING OF EMISSIONS AT 3x3 km RESOLUTION:



GRIDDING PROCEDURE

– SPATIALIZATION BASED ON LAND USE WEIGHTING PROFILES :

- Sector emissions are distributed among different CORINE land use classes according to their respective weighting factors.
- weighting factors were derived statistically from the calculation of “emission density” of each emission sector in each land use type



- Method developed in the EC-founded IMPRESAERO project**
- Also used in the previous City-Delta project: refinement of Land Use assignation profiles for Lombardy (Maffei, G. et al.)

**Winiwarter, W.; Vlachogiannis, D.; Gounaris, N.; Bartzis, J.; Ekstrand, S.; Tamponi, M.; Maffei, G.; Licotti, C.; Dore, C.; Hayman, G. (2001): Final Method Evaluation: Development of Spatially Resolved Emission Inventories for Milan and Athens; WP8000 of the EC research project IMPRESAREO; ARC Seibersdorf research Report, ARC-S-0154, 60 pages.

CONCLUSIONS

- In the frame of a collaborative research project between the EC JRC and the Lombardy Region (Northern Italy) a highly detailed and spatially resolved emission inventory was implemented for the Po Valley, giving priority to regional emission inventories.
- The integration of more regional emission inventories and their combination with the top-down disaggregated national inventory on to a wide area like the Po Valley represents the first experience in Italy
- Added value for AQ modeling: use of the most updated information (the modeling exercise is still in progress - benefits on results under evaluation)
- Added value for AQ scenarios: a series of regional emission scenarios is being prepared as input for the air quality forecasts at different time horizons within the next 15 years, based on information at municipal scale.
- The base case inventory and the emission scenarios are also the basis for a Regional Integrated Assessment Tool (under development) which is intended to support the implementation of cost-effective regional/local policies aiming at reducing the burden of adverse air quality on health.