AIR POLLUTION MANAGEMENT AND DECISION SUPPORT SYSTEMS: THE IN.EM.AR. EMISSION MODELLING SYSTEM

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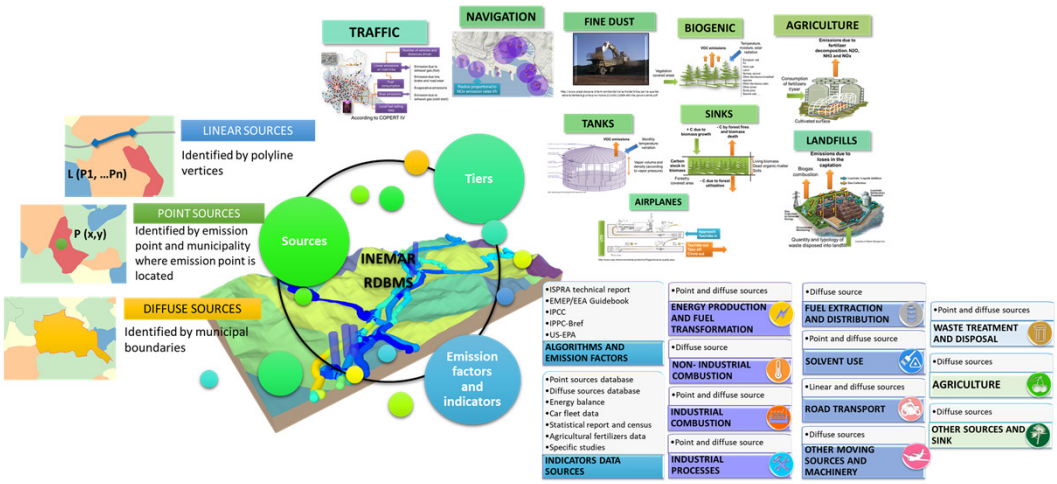


The IN.EM.AR. system (INventario EMmissioni Aria: www.inemar.eu) is being used in Lombardy for many years to estimate and update the regional Air Emissions Inventory.

It was set up in 1998 in the frame of the AQ Plan (PRQA) and is managed and developed since 2002 by Regional Environmental Protection Agency of Lombardy (ARPA). It has been developed over the years to take into account: new methodologies, data and information increased availability, stakeholder requests evolution, in short, to better face the new challenges in the field of air quality and GHGs.

It is able to provide estimates deriving from a combination of more than 250 activities and 12 fuels for pollutants of main interest for air quality (SO2, NOx, NMVOC, CO, NH3, PM2.5, PM10, TSP) and greenhouse gases (CO2, CH4, N2O and F-gases) at municipality level.
Emission data are also available for the carbonaceous fraction (BC, EC, OC) of particulate, polycyclic aromatic hydrocarbons PAHs (BaP, BbF, BkF, IcdP) and heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn). Emission inventories for Lombardy have been developed using INEMAR for several years: 1997, 2001, 2003, 2005, 2007, 2008, 2010, 2012, 2014 and 2017.

Approaches and mehodologies in Lombardy regional emission inventory

The system and methodologies implemented by ARPA Lombardy have been shared with other Italian regions increasing harmonisation in methods and estimates among regional local emission inventories (ARPA, 2021). This latter aim determines an increase in complexity managing local peculiarities. As a matter of facts, the implemented framework seems effective answering to different users' request with a proper codification of standard algorithms and parameters. The implementation of an edition of the regional emission inventory passes through the collection of several data as input.

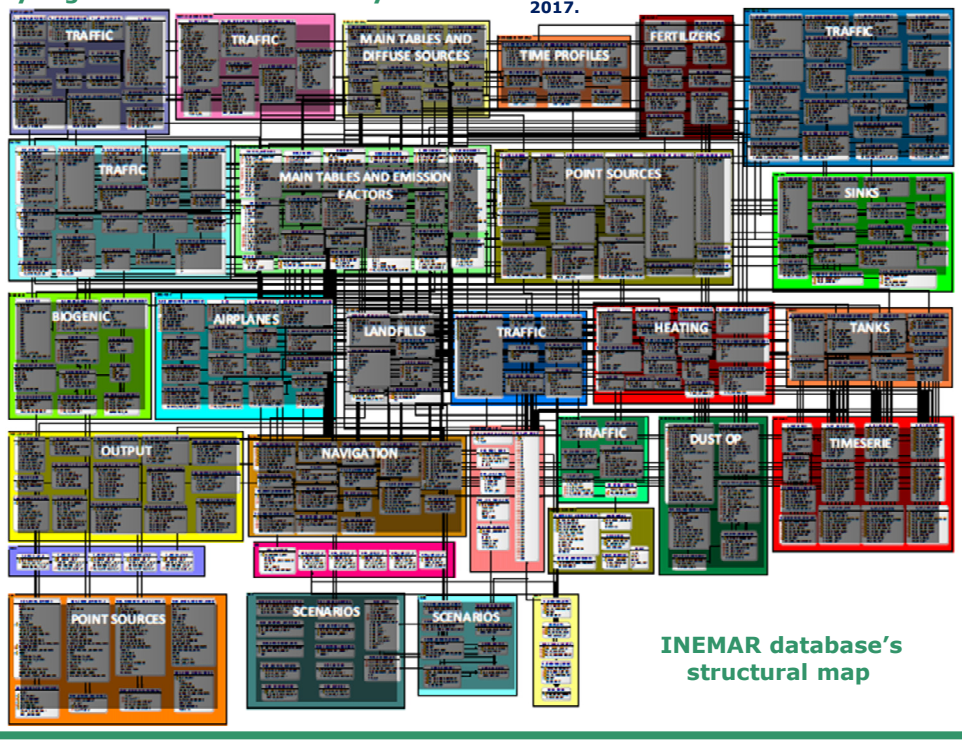
Different methodologies and approaches have been developed in order to: insert emission data with the correct codification, manage input and metafiles in emission inventory and share the methodology with other partners in an open and common space, such as Wiki pages (https://www.inemar.eu).

INEMAR is a database developed in RDBMS Oracle 10i, installed on servers and managed through various client locations.

The interface consists of a series of windows that can be viewed via a web browser. It is also possible to access data via ODBC connection.

INEMAR consists of a large number of tables grouping the data that are processed by various calculation modules through specific algorithms (as Airports, Agriculture, Biogenics, Areal Sources, Forestry, Landfills, Point Sources, Harbours, Fine Dust, Tanks, Speciation, Traffic, Domestic Heating, Scenarios etc.).

More details on http://www.inemar.eu/



INEMAR database's structural map

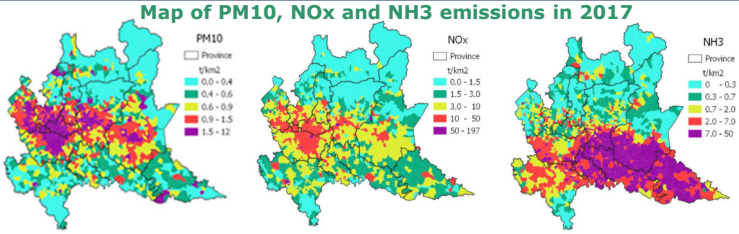
Emission inventory results

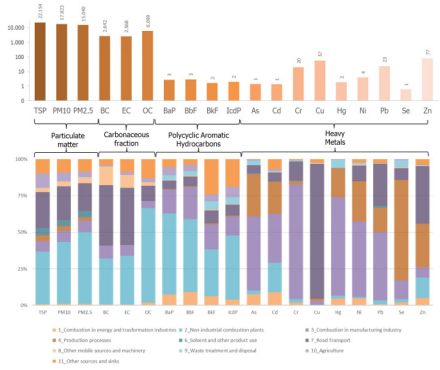
	SO_2	NO_x	VOC	CH_4	CO	CO_2	N_2O	NH_3	PM2.5	PM10	TSP	CO_2 eq	O_3 Precurs.	Tot. acidif. (H+)
	t/year	t/year	t/year	t/year	t/year	kt/year	t/year	t/year	t/year	t/year	t/year	kt/year	t/year	kt/year
Combustion in energy and trasformation industries	3.580	8.117	763	1.526	6.665	13.968	262	50	171	177	184	14.084	11.420	291
Non-industrial combustion plants	639	11.308	7.728	4.422	61.045	15.305	583	751	7.384	7.568	7.982	15.590	28.300	310
Combustion in manufacturing industry	4.035	17.294	3.292	697	12.154	11.997	299	396	1.141	1.347	1.608	12.104	25.738	525
Production processes	1.855	1.664	11.247	169	33.260	2.883	55	86	363	602	858	2.903	16.938	99
Extraction and distribution of fossil fuels			10.976	44.572								1.114	11.600	
Solvent and other product use	0	122	75.236	1	53	0		29	669	745	1.104	3.453	75.391	4
Road Transport	110	56.368	15.567	1.139	73.054	17.566	573	1.028	2.857	4.072	5.435	17.765	92.389	1.289
Other mobile sources and machinery	197	12.778	1.270	27	4.866	1.417	47	2	594	595	596	1.431	17.394	284
Waste treatment and disposal	642	2.643	875	66.222	1.104	638	422	544	33	34	38	2.419	5.148	110
Agriculture	43	697	60.791	220.761	2.221		10.265	94.070	548	1.075	2.194	8.578	64.976	5.550
Other sources and sinks	99	484	55.314	5.573	13.805	-2.613	4	157	1.281	1.607	2.154	-2.472	57.501	23
Total	**11.180**	**111.475**	**243.058**	**345.107**	**208.227**	**61.161**	**12.510**	**97.114**	**15.040**	**17.823**	**22.154**	**76.970**	**406.794**	**8.485**

Emissions in Lombardy in 2017 by SNAP group – final data

Total estimates of emissions are provided for about 1500 municipalities of the Lombardy region. Regional emissions of macropollutants estimated in the year 2017 are shown with detail of SNAP group.
The map shows how the largest primary PM10 emissions per unit of surface area of each Lombard municipality affect the main urban areas of the region, the municipalities adjacent to the main motorway arches and some Alpine and pre-Alpine areas characterized by the domestic use of wood biomass. The greatest NOx emissions are estimated near major roads and motorways in relation to vehicular traffic and ammonia is emitted mainly in the plain areas characterized by agricultural vocation.
The heating sector, mainly due to fuelwood, and the road transport are the main emission sources of PM in Lombardy estimated for 2017, TSP are also emitted from agriculture sector.

Map of PM10, NOx and NH3 emissions in 2017





Lombardy emission estimates for 2017 in t/year (log scale) and emission share among different sectors.

Conclusions

Regional emission inventory for Lombardy Region is regularly updated considering activity data and new methodology improvements and has been assumed as a reference indicator in regional policy development. The methodology is defined in order to obtain the deepest level of estimation minimizing the uncertainty level. Classification of new and diffuse technologies, reduction in uncertainties in determination of indicators and relative fast updating in algorithm and emission factor are common tasks in the update and improvement of the emission inventory based on INEMAR system.