AIR QUALITY ASSESSMENT AT A BIG INDUSTRIAL PLANT AND POSSIBLE USE OF CAMS PRODUCTS

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ILVA STEEL FACTORY

VIA ARCHIMEDE

VIA MACHIAVELLI

TARANTO

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Taranto Industrial Area and AQ monitoring stations

Via Machiavelli
PM10
PM2.5
BaP

Via Archimede
PM10

Talsano
PM10
BaP

Via Adige
PM10
BaP

Number of daily limit value exceedances (without African outbreaks) for PM10

Via Machiavelli

Via Archimede
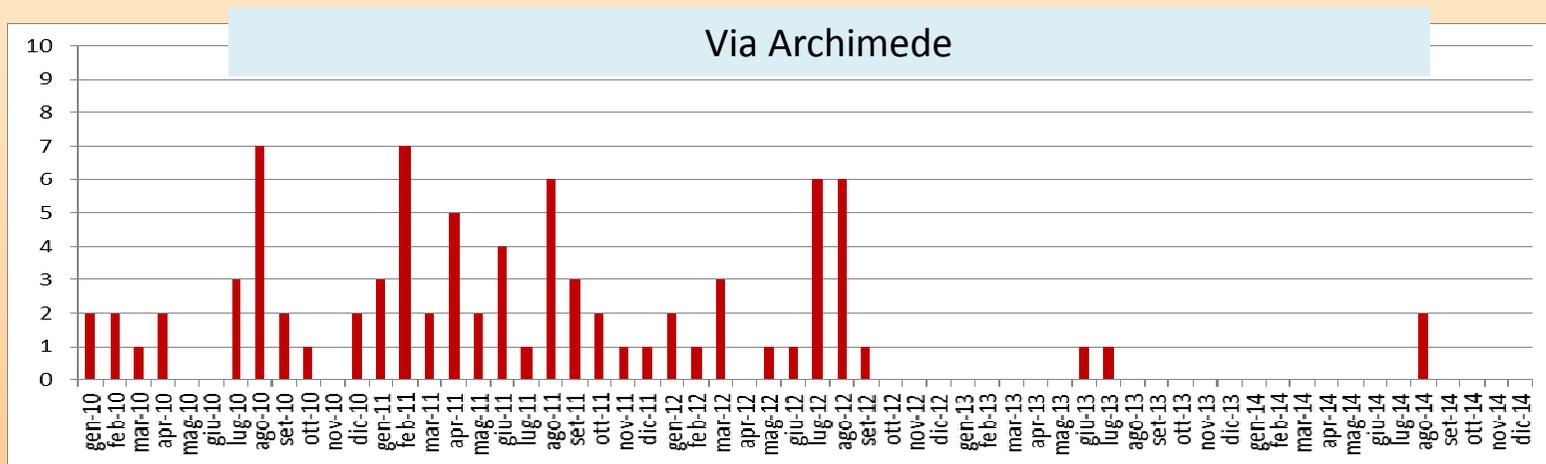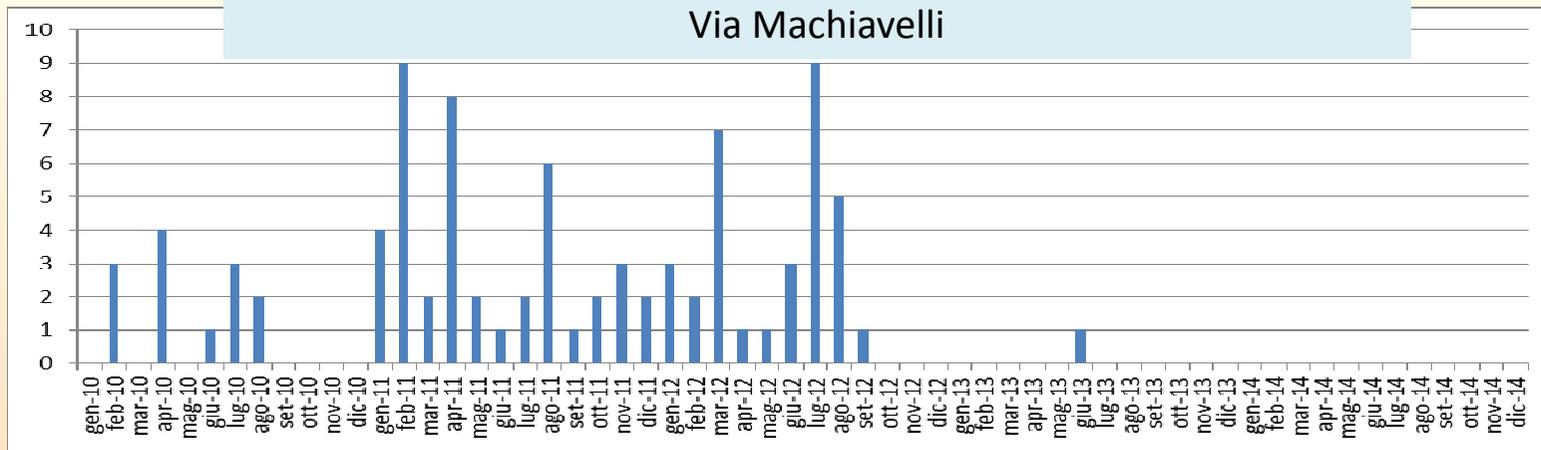
Annual average for BaP (ng/m3) from 2010 to 2014
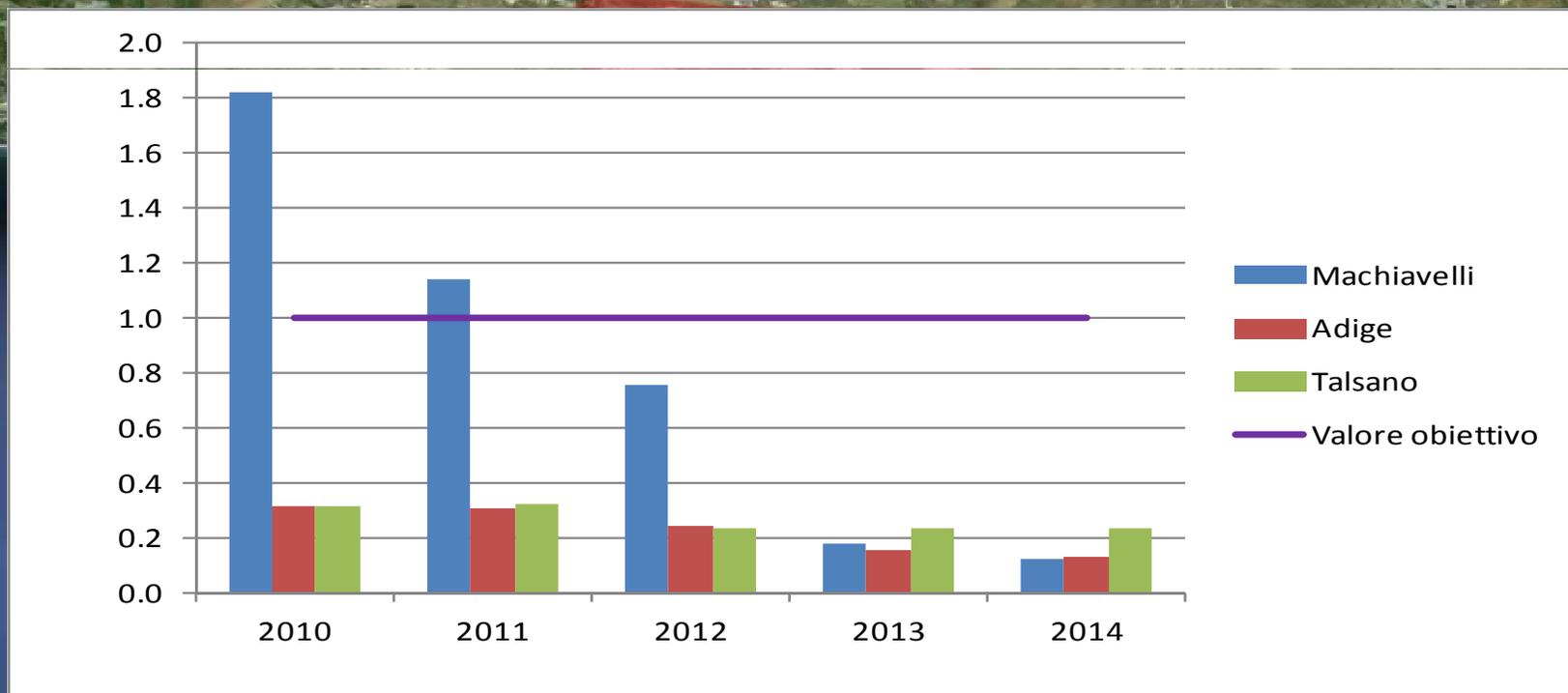
BaP moving averages (ng/m3) from 2009 to 2014 at Taranto - Machiavelli, Adige, Talsano monitoring stations
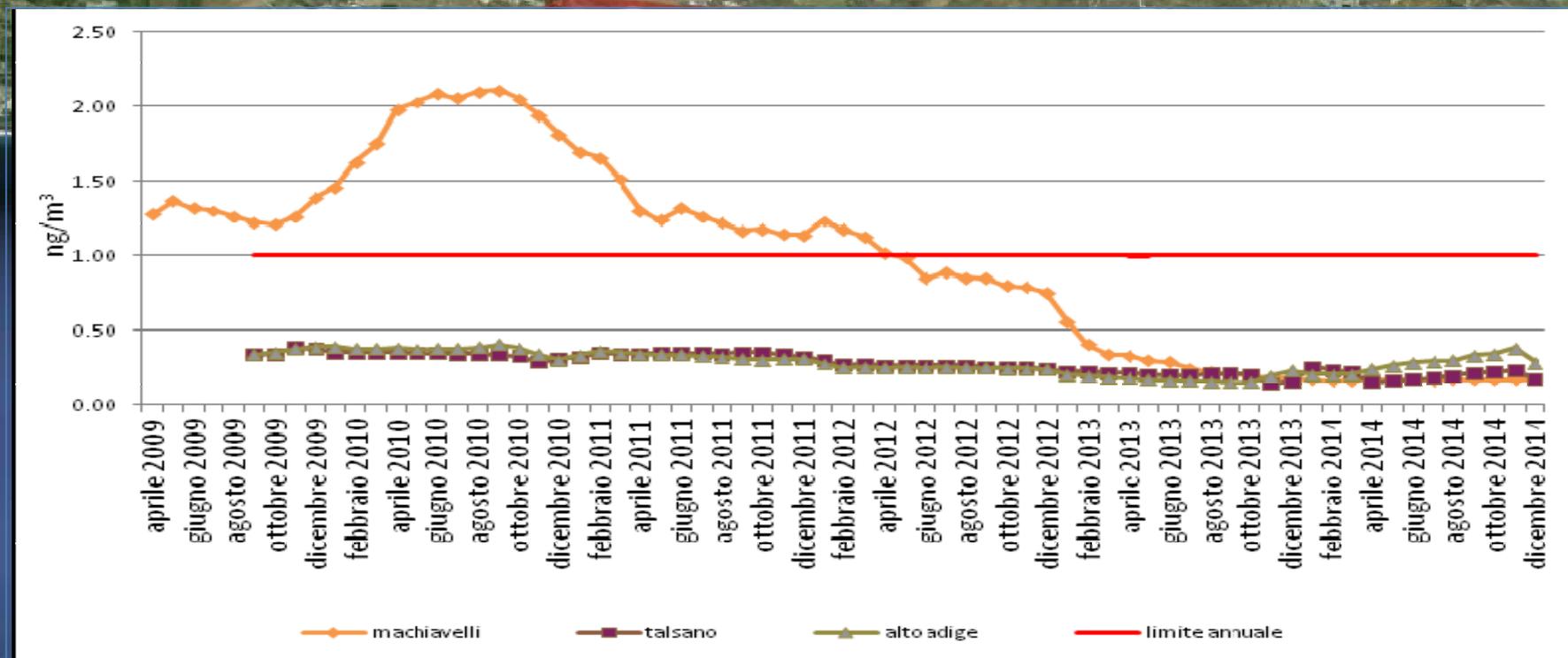
BaP Annual averages (ng/m3) at Taranto from 2010 to 2014

BaP (ng/m3)	Machiavelli	Adige	Talsano	Deledda	Target value (ng/m3)
2009	**1,39**	0,39	0,38	/	
2010	**1,82**	0,31	0,31	/	
2011	**1,14**	0,31	0,32	/	1
2012	0,76	0,24	0,24	/	
2013	0,18	0,16	0,24	0,18*	
2014	0,12	0,13	0,23	0,15	
*from april to december					

PM2.5 moving averages
from 2010 to 2014

PM10 – ANNUAL AVERAGES

- Via MACHIAVELLI
- Via ARCHIMEDE
- Via ALTO ADIGE
- STATTE - SORGENTI
- TARANTO - TALSANO
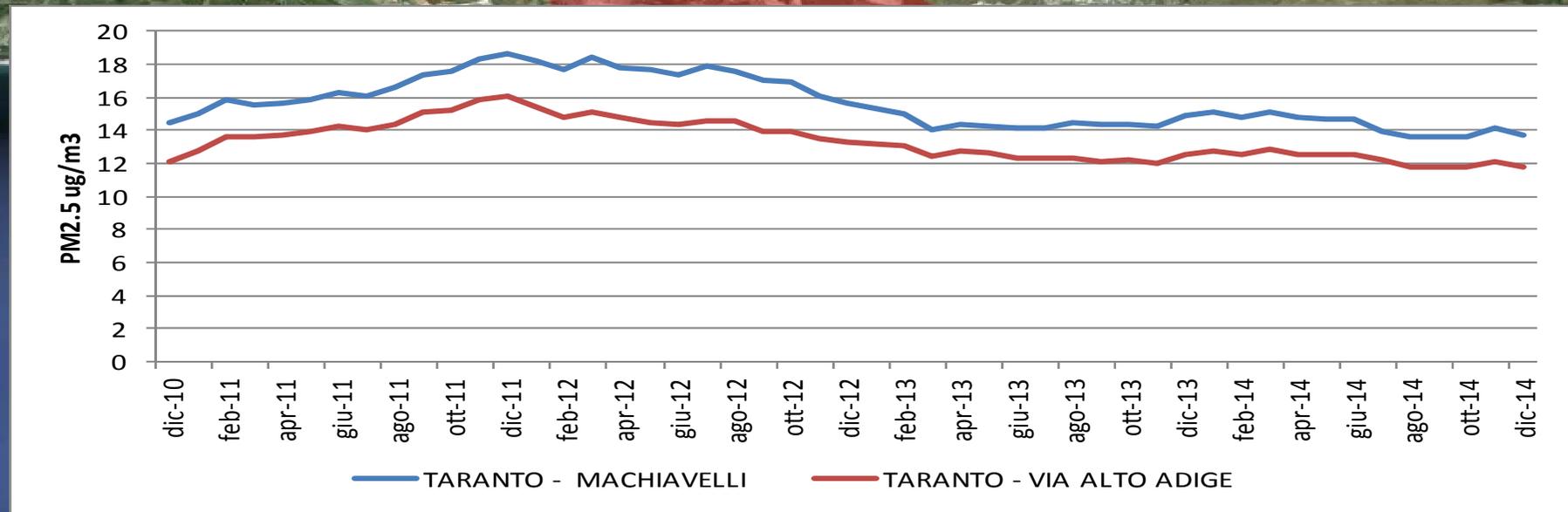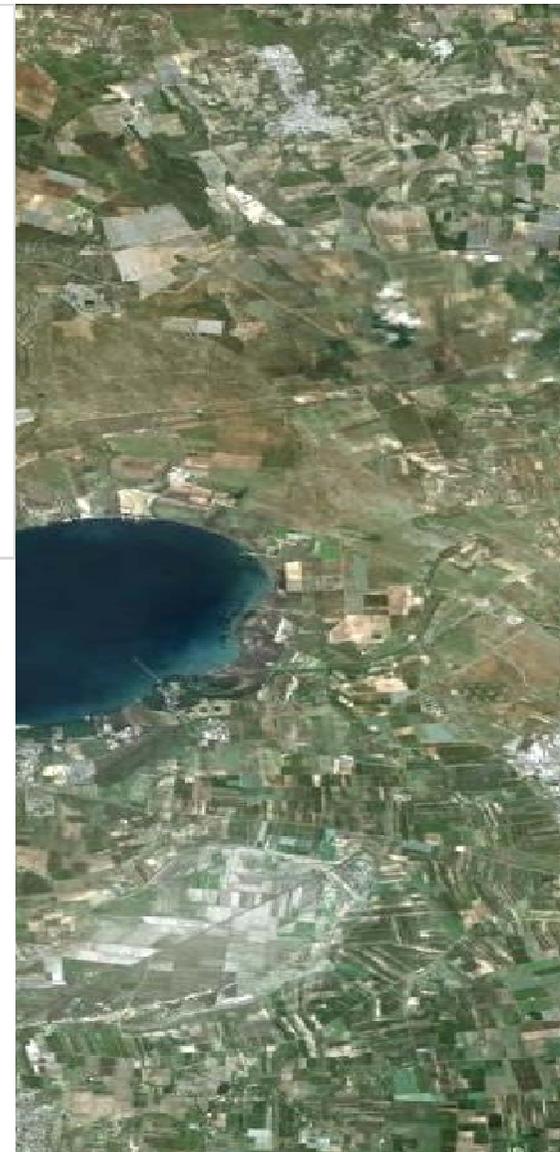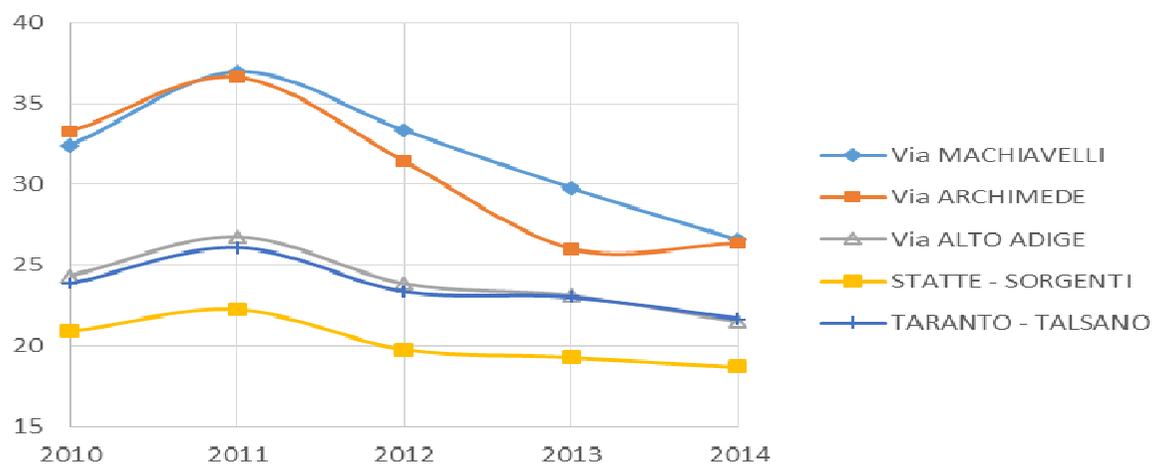
ILVA PRODUCTION DATA
2010- 2014

- Solid steel (kton/y)
- Coke (kton/y)
- Sinter (kton/y)
- Pig iron (kton/y)
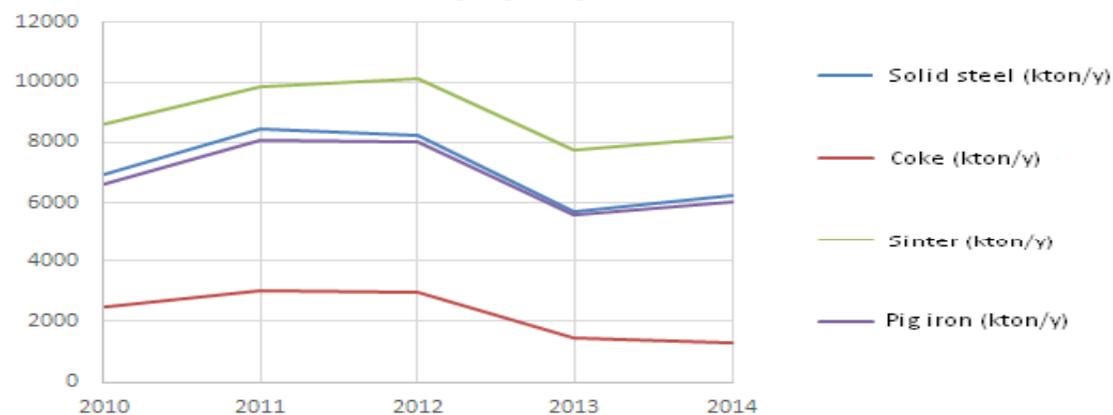
BaP annual concentrations and ILVA coke production
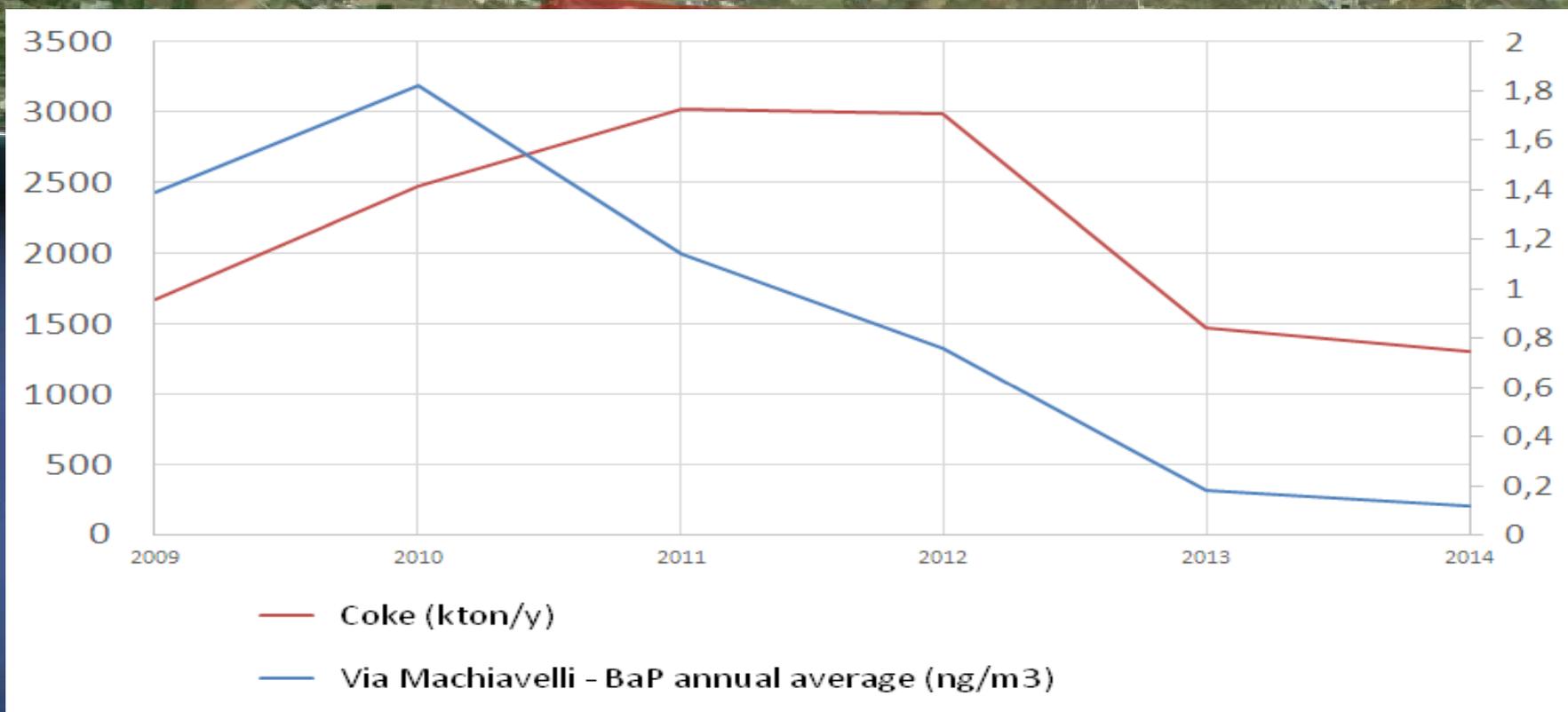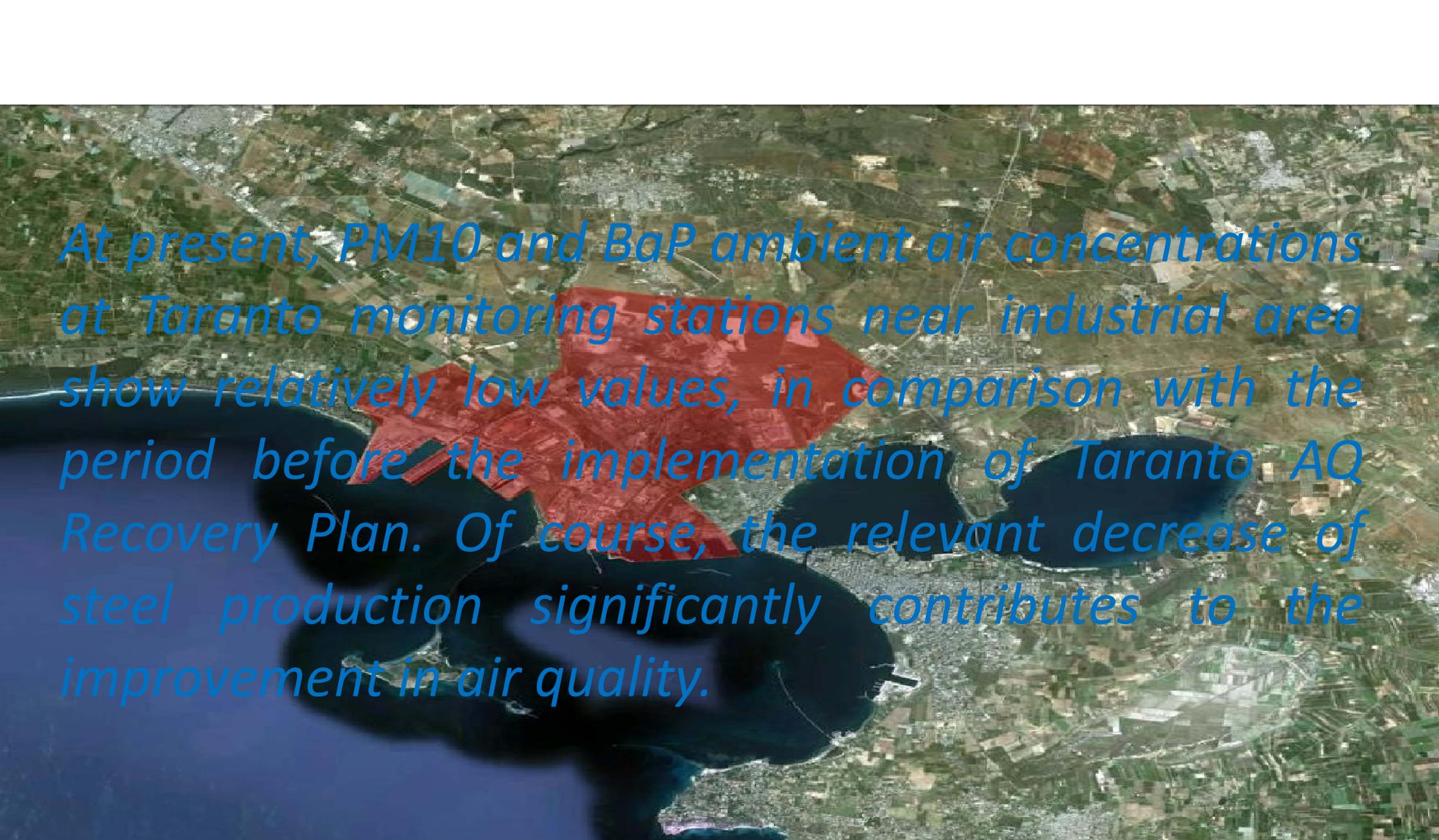
Legend:
- Coke (kton/y)
- Via Machiavelli - BaP annual average (ng/m3)

At present, PM10 and BaP ambient air concentrations at Taranto monitoring stations near industrial area show relatively low values, in comparison with the period before the implementation of Taranto AQ Recovery Plan. Of course, the relevant decrease of steel production significantly contributes to the improvement in air quality.

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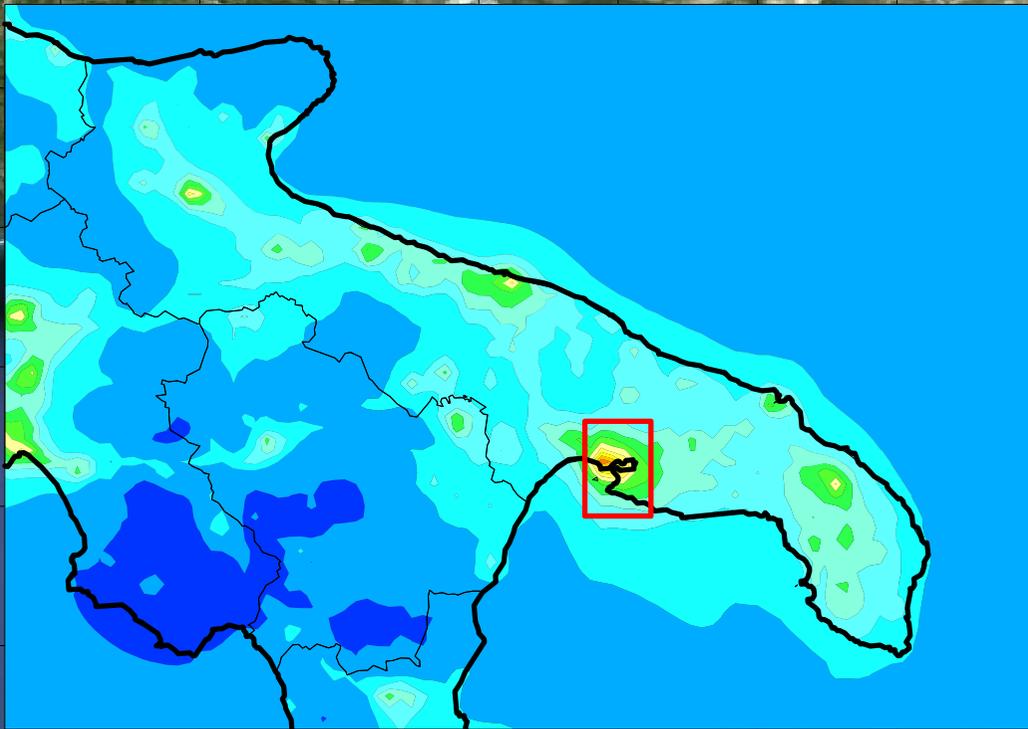
MINNI Project
2007

Primary PM10 contribution, simulated for 2007 by the FARM photochemical model at 4X4 spatial resolution by ENEA (MINNI Project), accounts 70% of the total annual average PM10 concentration near the industrial area.

Increasing distance from industrial area, the primary PM10 contribution decreases to sixty-fifty percent.

PRIMARY PM10 CONTRIBUTION (%)
FOR ANNUAL PM10 AVERAGE
(except sea salt and terrigenous compounds)

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The approach: Lagrangian particle SPRAY model

The lagrangian model is able to reconstruct local primary pollutant concentration fields in a complex meteorological area, where industrial emissions are particularly relevant.

Therefore, Arpa Puglia carried out a modelling study:

- To realize source apportionment for primary macropollutants (NOx, SO_2, primary PM10, primary PM2.5 and C_6H_6) in order to better understand:
  - ✓ The impact of different pollutant anthropogenic sources to annual total concentrations;
  - ✓ The spatial distribution of these macropollutants on the studied area.

- To achieve a "refined" source apportionment for industrial primary PM10, because dangerous micropollutants (POP's and heavy pollutants) can be conveyed by PM.

SIMULATION DOMAIN

Grid (Nx ,Ny , Nz): 71x 71x 15

Lx x Ly= 30 km x 30 km

Δx=Δy=500m

Top Domain = 5000m

Meteorological profiles supplied for 2007 by the national Minni project (www.minni.org)

Topography and surface roughness

SWIFT → Computation of the 3D meteorological fields over grid.

Landuse

SURFPRO → Computation of 2D turbulence parameters

Emissions

SPRAY → Computation of 3D short term hourly concentrations fields

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SOURCE APPORTIONMENT FOR PRIMARY PM10

TOTAL ANNUAL AVERAGE MAP

Legend

- Modelling domain
- Municipal boundaries
- Towns
- Air quality stations

PM10 ug/m3
- 0 - 1
- 1,1 - 10
- 10,1 - 20
- 20,1 - 30
- 30,1 - 40
- 40,1 - 50
- 50,1 - 60
- 60,1 - 70
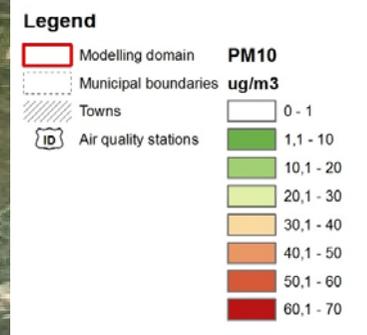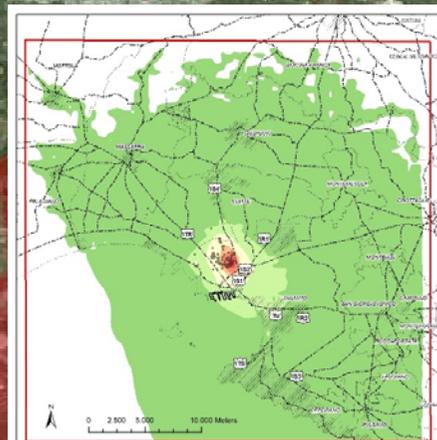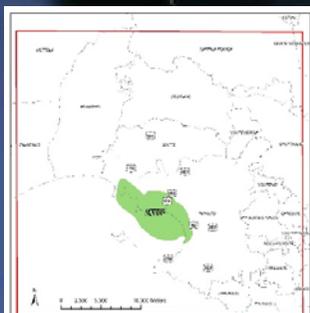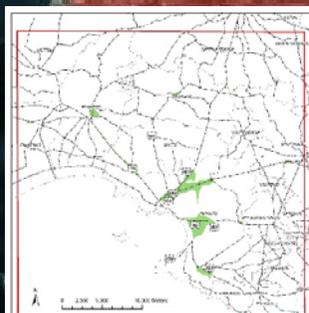
THE HARBOUR   **TRAFFIC**   **INDUSTRY**   **RESIDENTIAL HEATING**

In Taranto area, industry is the most important contributor to total annual concentration of primary PM10.

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SOURCE APPORTIONMENT FOR INDUSTRIAL PRIMARY PM10

INDUSTRY　　　**STEEL PLANT**　　　**OTHER INDUSTRIES**
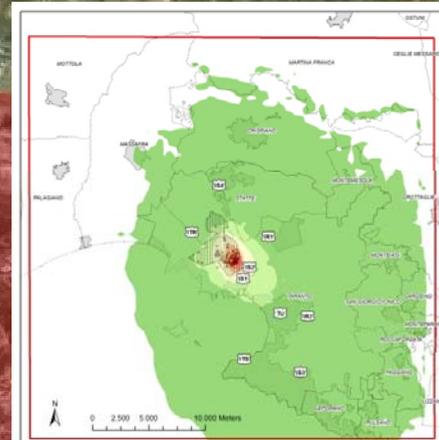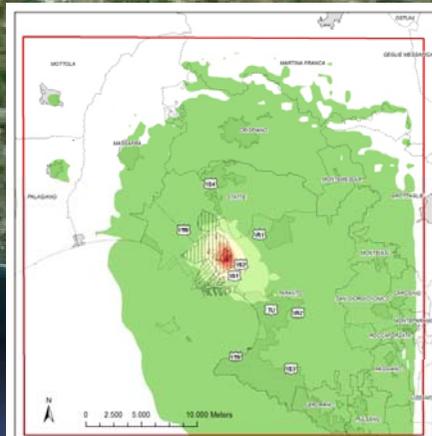
Industrial PM10	Paolo VI	Via Archimede	Via Machiavelli	SS7Wind	Via Alto Adige	Talsano	Capo San Vito	Statte	Casa Circondariale
Steel Plant	96%	98%	97%	95%	96%	94%	94%	96%	95%
Other Plants	4%	2%	3%	5%	4%	6%	6%	4%	5%

At the all monitoring stations, steel plant emissions account for over 90% of the industrial primary PM10 concentrations.
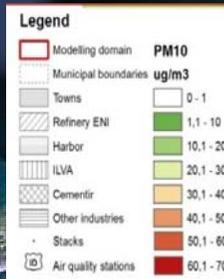
Legend

Modelling domain	**PM10**
Municipal boundaries	**ug/m3**
Towns	0 - 1
Refinery ENI	1,1 - 10
Harbor	10,1 - 20
ILVA	20,1 - 30
Cementir	30,1 - 40
Other industries	40,1 - 50
Stacks	50,1 - 60
Air quality stations	60,1 - 70

Stations	type
IS1- Via Machiavelli	Industrial suburban
IS2 - Via Archimede	Industrial suburban
IS3 – Talsano	Industrial suburban
IS4 – Statte	Industrial suburban
IR1 - Paolo VI	Industrial rural
IR2 - Casa Circond.	Industrial rural
ITR - SS7 Wind	Industrial/traffic rural
ITS - San Vito	Industrial/traffic suburban
TU - Via Adige	Traffic urban

SOURCE APPORTIONMENT FOR PRIMARY PM10 FROM STEEL PLANT
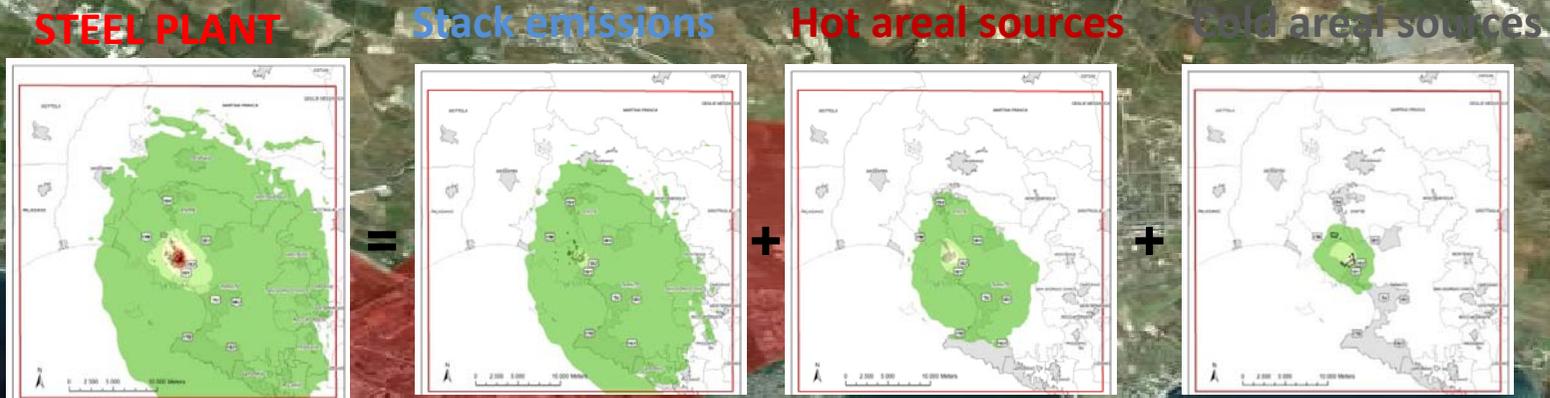
STEEL PLANT　　**Stack emissions**　　**Hot areal sources**　　**Cold areal sources**

	Paolo VI	Via Archimede	Via Machiavelli	SS7Wind	Via Alto Adige	Talsano	Capo San Vito	Statte	Casa Circondariale
Stack emissions	54%	39%	41%	52%	58%	63%	62%	58%	58%
Warm areal emission	39%	48%	45%	33%	36%	33%	32%	35%	36%
Cold areal emissions	7%	13%	15%	15%	6%	5%	6%	6%	6%

Cold areal emissions have the shortest range impact; increasing distance from the industrial area, the relative impact of stack emissions becomes more important.

Legend

	PM10 ug/m3
Modelling domain	
Municipal boundaries	
• Stacks	0 - 1
Towns	1,1 - 10
Areas hot	10,1 - 20
Mining parks	20,1 - 30
[ID] Air quality stations	30,1 - 40
	40,1 - 50
	50,1 - 60
	60,1 - 70

Stations	type
IS1- Via Machiavelli	Industrial suburban
IS2 - Via Archimede	Industrial suburban
IS3 – Talsano	Industrial suburban
IS4 – Statte	Industrial suburban
IR1 - Paolo VI	Industrial rural
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The results of Lagrangian modeling study contributed to the elaboration of Taranto Air Quality Remediation Plan (Regione Puglia, 2012).

REGIONE PUGLIA
Assessorato alla Qualità dell'Ambiente

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PIANO CONTENENTE LE PRIME MISURE DI INTERVENTO PER IL
RISANAMENTO DELLA QUALITÀ DELL'ARIA NEL QUARTIERE TAMBURI (TA)
per gli inquinanti PM_{10} e Benzo(a)Pirene
ai sensi del D.lgs.155/2010 art. 9 comma 1 e comma 2

luglio 2012

Environmental Health Assessment

The same modelling system was used to draw up the first Environmental Health Assessment Report concerning Taranto steel plant, as requested by a Regional Legislative Act (LR 21/2012, Regione Puglia) for the most polluting plants in Apulia region.

In particular, the modelling system was used to evaluate the environmental exposure level of Taranto area resident population to dangerous micropollutants (POPs and heavy metals) emitted by the steel plant.

Using equations proposed by the California OEHHA Air Toxics Hot Spots Risk Assessment Guidelines, the inhalation dose for each pollutant was calculated and then multiplied by the specific inhalation slope factor to obtain life-time cancer risk for each pollutant. The individual pollutant cancer risks were then added up to give the overall plant inhalation cancer risks plotted in a GIS map.
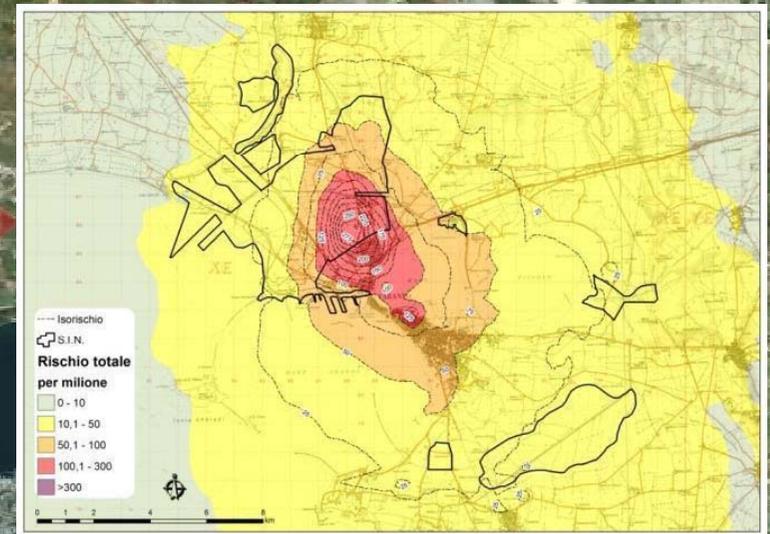

Total inhalation carcinogenic risk map

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MACC-III supports French authorities on elevated SO2 values

In the middle of September several European countries were surprised by measurements of high sulphur dioxide concentrations at ground level. SO2 is known as a precursor for acid rain, but also acts as an irritant to the respiratory system as well as being a precursor of sulphate aerosol. Due to strong European efforts over the last decades to reduce SO2 emissions, high concentrations of SO2 are now quite rare in Western Europe -except in specific areas affected by industrial or shipping emissions. So what was going on?

French in-situ air quality stations observed high values of SO2, especially along the northwestern coast, as seen in the figure on the right. However, the hypothesis that these high values could be linked to ship emissions trapped in the lower atmosphere appeared unlikely because they were exceptionally high and observations in the United Kingdom and the Netherlands (Figure below) also showed high concentrations between 21 and 25 September. This all pointed towards an episode of large spatial extent.

Philippine-Stelleweg / SO2 / max=82 ug/m3

Image provided by LML/RIVM (www.lml.rivm.nl)
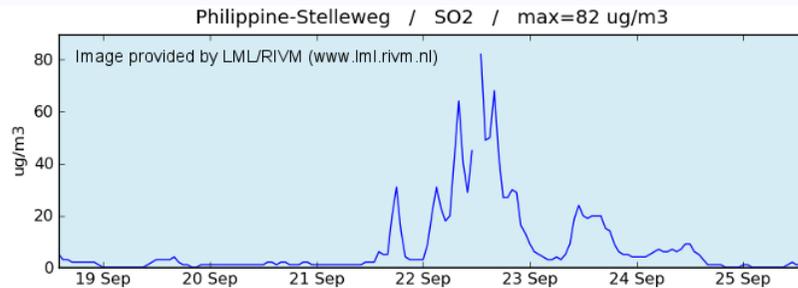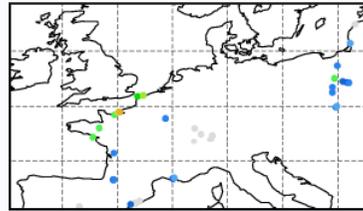
The situation was explained by the MACC near-real-time forecasting system thanks to its use of satellite observations to constrain the model forecasts. The OMI satellite instrument observed concentrations of volcanic SO2, emitted by the Icelandic Bardarbunga volcano, and these observations were assimilated by the MACC system. The subsequent 5-day forecast then captured the transport of this plume of volcanic SO2 southward reaching the Channel on 23 September (Figure below, left). A parallel forecast (Figure below, right), for which no OMI data were used, further identified the volcanic nature of the plume. No elevated SO2 values were forecasted without assimilating the OMI data, which means that "normal" emissions of SO2 (including shipping and industrial activities) could not explain the observed situation.
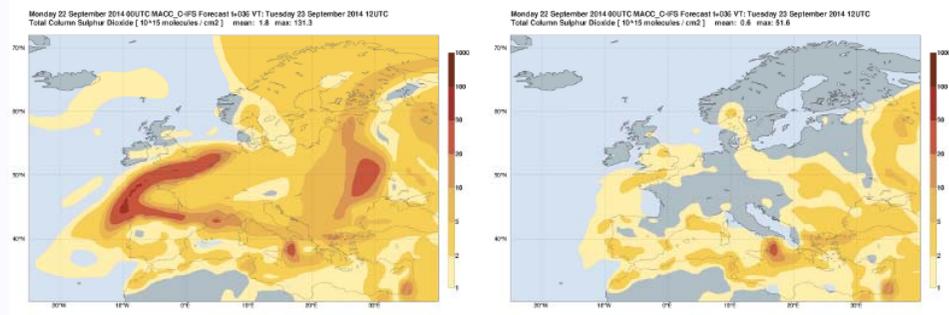
Possible use of online analysis and forecasting CAMS maps for supporting AQ measured data validation and interpretation

Air quality modeling assessment in Apulia region 2013

The system is feeded with:
- boundary and initial conditions:
  - provided each 3 hours by "Quale Aria" forecasting system for particle and gas phase pollutants;
  - provided by "EMEP-MSCE" climatological model for heavy metals and PCDD/F.
- metereological forecasts at +24h provided by RAMS model;
- regional emission inventory "Inemar" on municipal basis for 2010 (with actualization to 2013 for some sectors, among which steel production) and national ISPRA emission inventory on provincial basis, for 2010.
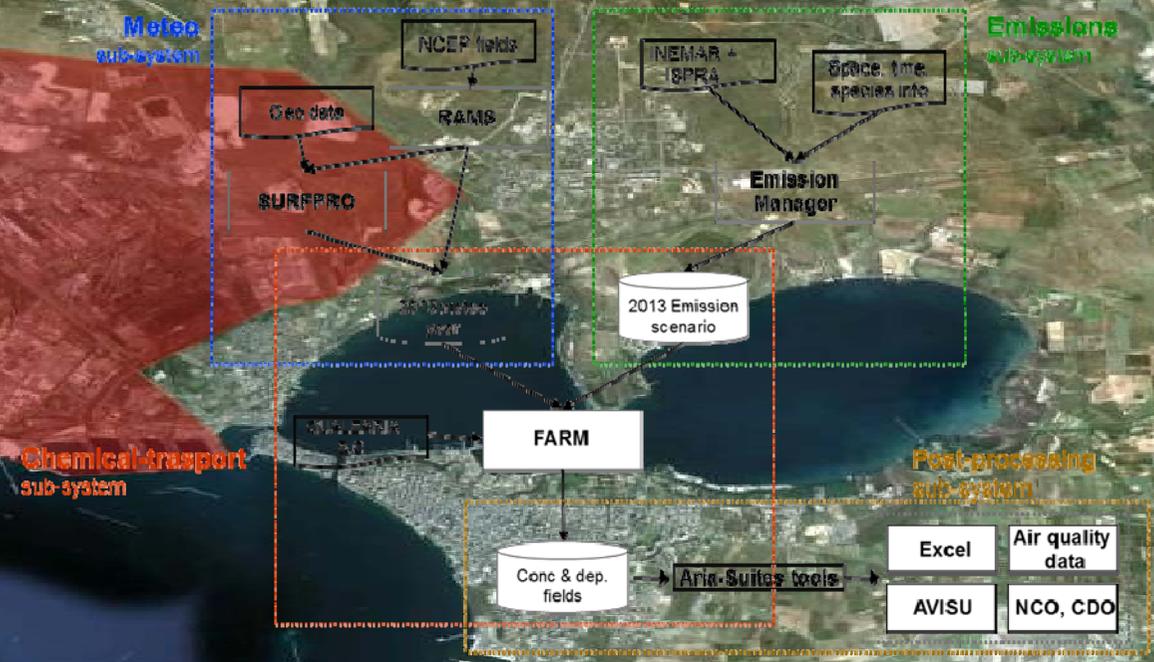
Forecasting and Daily Assessment AQ Modeling System for Apulia Region at 4km resolution, with nesting at 1km for Taranto area

Dati di input Meteorologici (WRF)

Dati geografici e cartografici, condizioni iniziali e al bordo

Dati di input di emissioni

Pre-processore micro-meteorologico

Modello fotochimico di dispersione di inquinanti

Pre-processore delle emissioni (EMMA)

Campi 2D e 3D di concentrazione di inquinanti

Post-elaborazioni
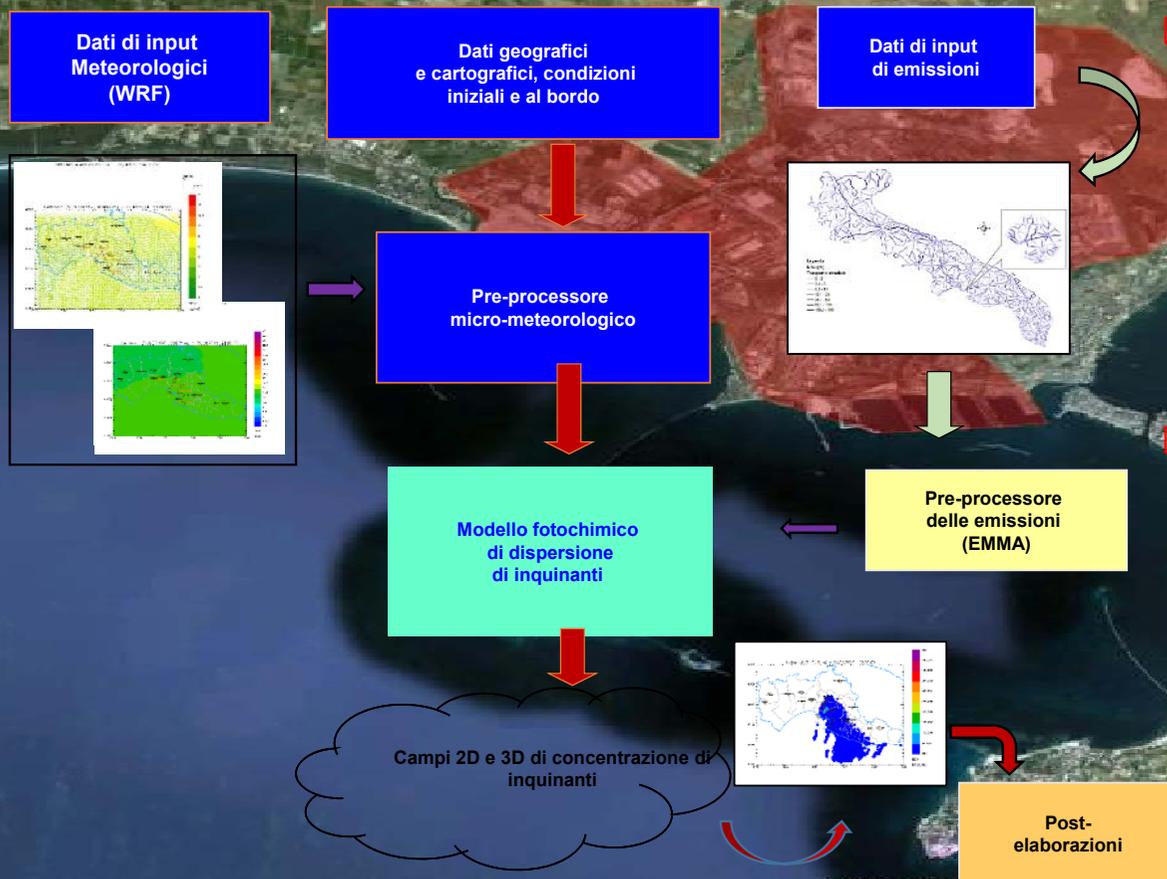
- **AQ Forecasting System**: starting from +72 WRF meteorological forecasts, the modelling system will provide on hourly basis PM10, PM2.5, NO_2, NO_x, NO, O_3, SO_2, Pb, C_6H_6, CO, BaP, Cd, As, Ni, Hg, PCDD/F concentrations for the whole Apulia region (4km resolution) e for Taranto area (1km resolution).

- **Daily AQ Assessment System**: the system will provide the hourly reconstruction of ground concentrations of PM10, PM2.5, NO_2, NO_x, NO, O_3, SO_2, C_6H_6, CO, referred to the previous day, for Apulia region and Taranto area, obtained by modelling system and AQ data assimilation.

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MACC Products – Regional Air Quality

Products

The MACC regional air quality models provide daily over Europe (30°N - 70°N, 25°W – 45°E) :

- Ensemble analyses and forecasts : 4-days forecasts (0...96 figures) of ozone (O_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), particulate matters with size below 10 mm (PM10) and below 2.5 mm (PM2.5) at surface, at 500m, 1000m and 3000m altitude, birch pollen at surface during Spring (1st of March to 30th of June) on an hourly basis from the Ensemble, and a posteriori analyses (-24...-1 figures) of ozone (O_3) at the surface from the Ensemble. The Ensemble is the best estimate of air pollutant concentrations.

- EPSgrams : 4-days forecasts of O_3, NO_2, SO_2 and PM10 at the location of 41 major European cities and their uncertainty via EPSgrams plots.

- Individual analyses : Hourly analyses at surface for the past 24 hours from the 7 production models (species depend on the model)

- Individual forecasts : 4-days forecasts (0...96 figures) of ozone (O_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), particulate matters with size below 10 mm (PM10) and below 2.5 mm (PM2.5) at surface, at 500m, 1000m and 3000m altitude, birch pollen at surface during Spring (1st of March to 30th of June) on an hourly basis from the seven models.

- RAQ near real time observations : hourly observations for ozone (O_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matters with size below 10 mm (PM10) for the day before, collected from the EEA NRT service.

- Verification of the forecasts and analyses against European surface station observations for O_3, NO_2, SO_2, CO and PM10 : maps and statistical indicators.

PROS

- MACC data are producted by assimilation of satellite (Sentinel) and In-situ AQ data (using NRT, delayed-mode (?) and reanalysis(?))
- Accounts for Saharan avvections (?)

CONS

- Only SO2, NO2, CO, PM10 and PM2.5 are considered;
- It is necessary to carry out species matching;
- Few vertical levels (up to 3000 m);
- MACC data are not validated on Italy;
- Data analysis and forecasts are available only at 12 UTC ;
- Download times - subsettings (?);
- Archiving (?).
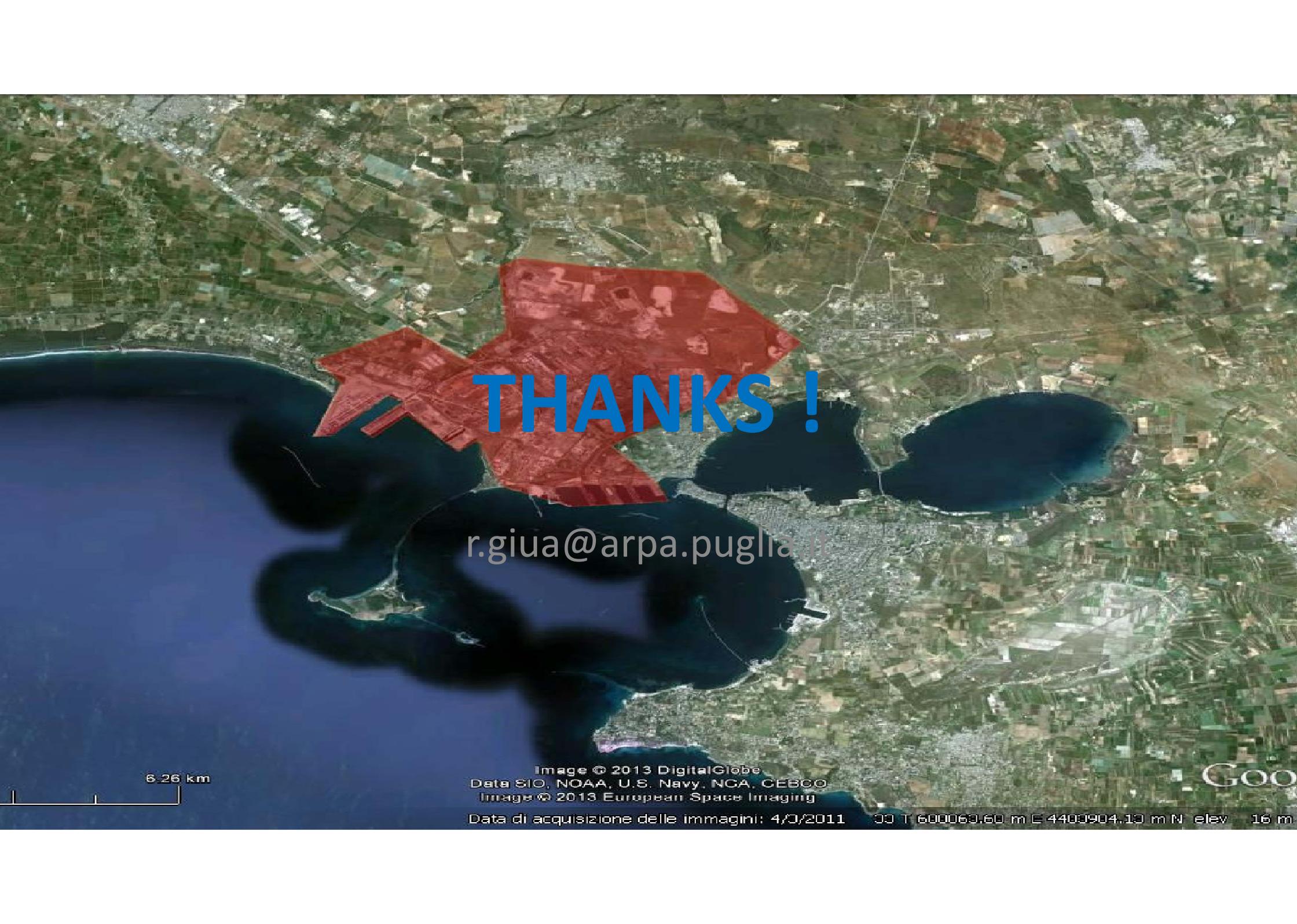
THANKS !

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Refinery

INTEGRATED IRON AND STEEL PLANT

TARANTO
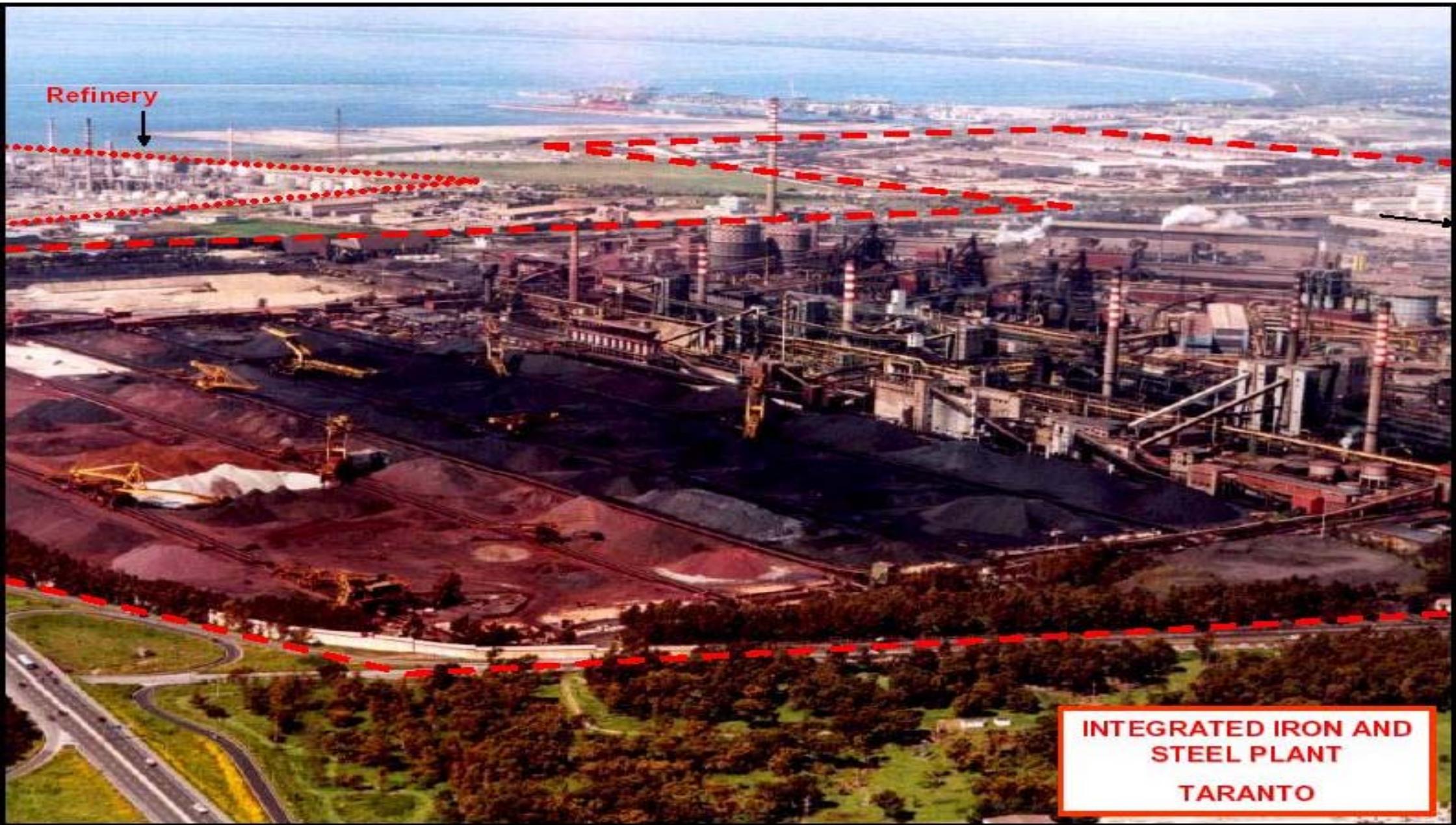
ILVA DOAS Monitoring Network
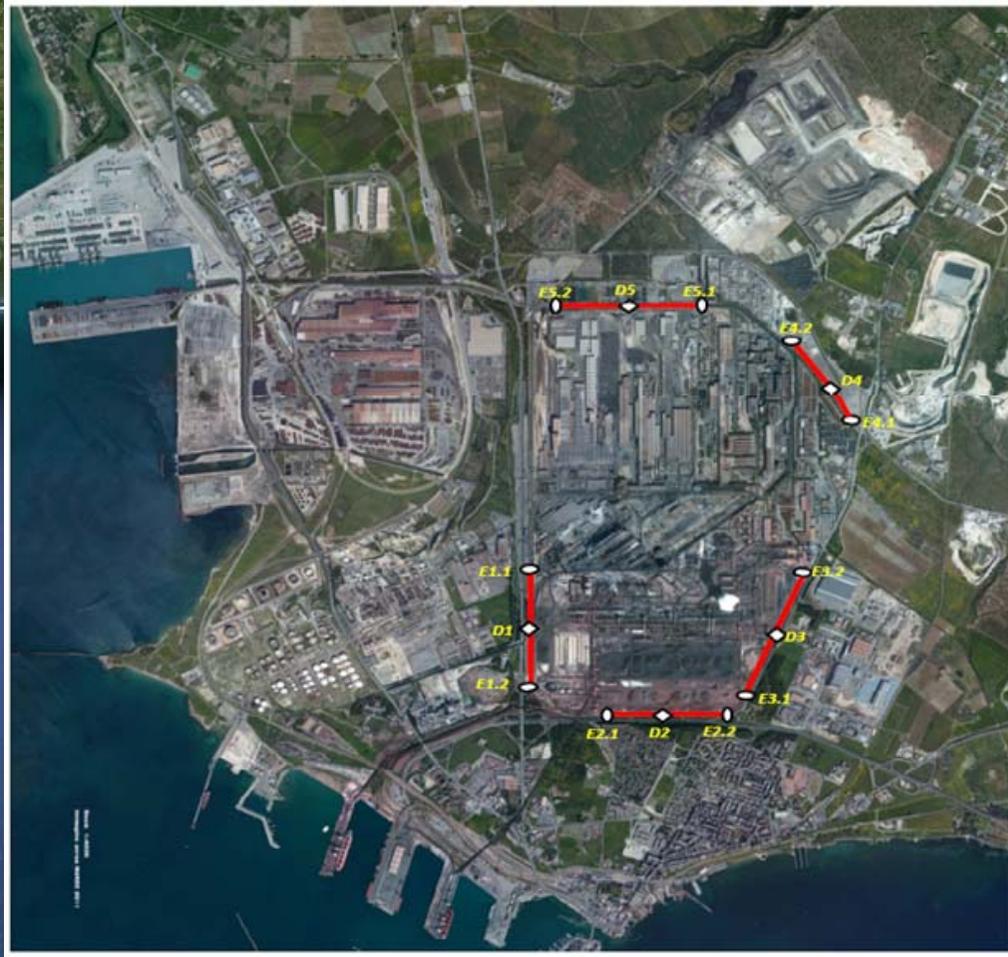
D1	Doas 1 Direzione	
D2	Doas 2 Parchi	
D3	Doas 3 Agglomerato	
D4	Doas 4 Port. Imprese	
D5	Doas 5 Area 12	

STATION	POLLUTANTS MONITORED
DOAS 1 DIREZIONE	
DOAS 2 PARCHI	
DOAS 3 AGGLOMERATO	SO_2, NO_2, O_3, Benzene, Toluene, o-Xilene, m-Xilene, p-Xilene, Naftalene
DOAS 4 PORTINERIA IMPRESE	
DOAS 5 AREA 12	

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BENZENE