Gli studi di coorte di Taranto e Brindisi
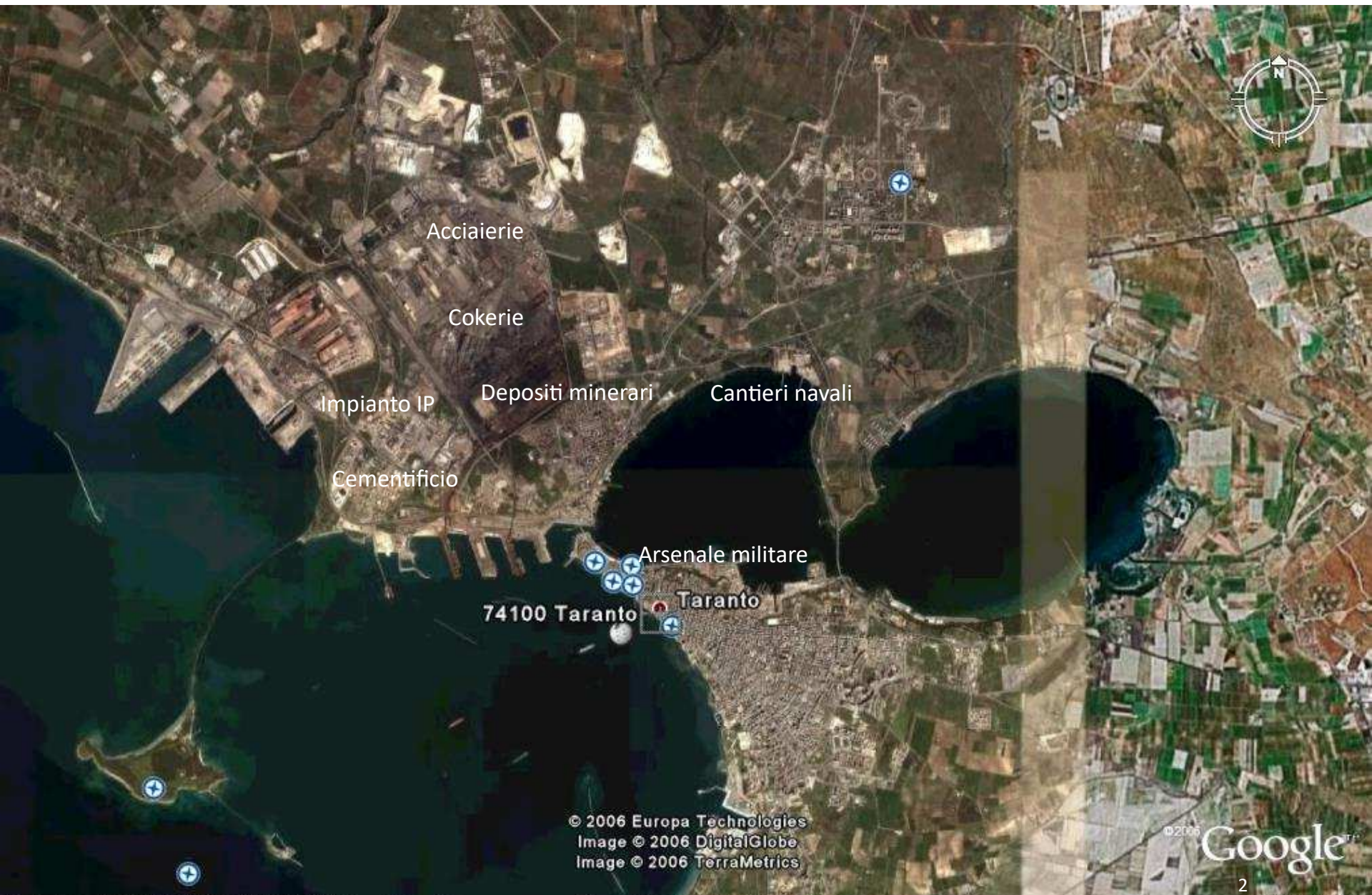
Acciaierie

Cokerie

Depositi minerari   Cantieri navali

Impianto IP

Cementificio

Arsenale militare

74100 Taranto   Taranto

Google

Puntatore 40°29'19.67" N 17°14'40.42" E   elev 0 m   Streaming ||||||||| 100%   Alt 17.01 km

The industrial area of Taranto
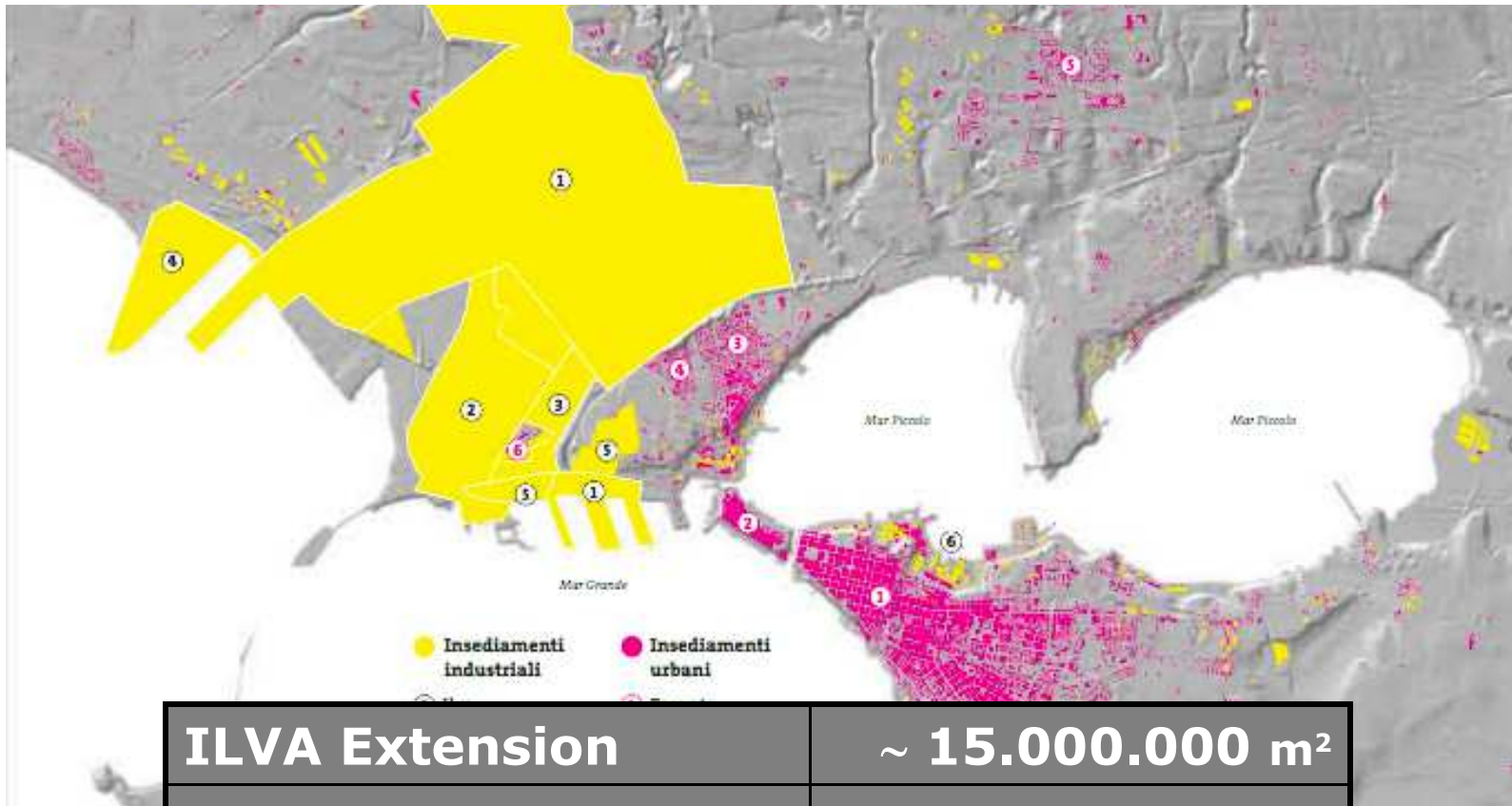
ILVA Extension	~ 15.000.000 m²
Railway network	~ 200 km
Road network	~ 50 km
Conveyors	~ 190 km

Source apportionment, 2009 data
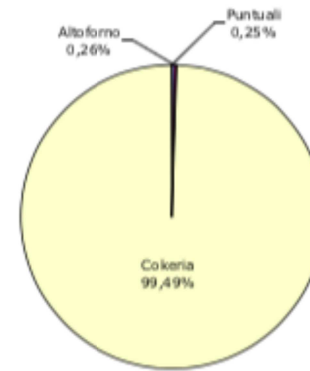
The industrial area of Brindisi

Environmental stressors:
- Thermoelettric power plants
- Petrochemical complex
- Harbor
- Airport
- Landfills and Incinerator
- Other plants
- Traffic and biomass heating

Carovigno

San Vito dei Normanni

Brindisi

Mesagne

San Pietro Vernotico
Torchiarolo

Cellino San Marco

GOVERNANCE AMBIENTE E SALUTE NEI SITI CONTAMINATI:

• Incorporare strumenti per la <u>valutazione e la gestione **preventiva**</u> del rischio sanitario nelle procedure autorizzative, che prescindano dal mero rispetto dei limiti ambientali

• <u>Vulnerabilità collettiva</u> che affligge le comunità che condividono **l'esposizione a fattori di rischio ambientali**, che ne modificano **il profilo di salute** e di conseguenza i **bisogni** che interpellano la capacità delle istituzioni di offrire **risposte** adeguate.

Monitoraggi ambientali	**Valutazione dell'esposizione**
Sorveglianza epidemiologica	**Sorveglianza sanitaria**
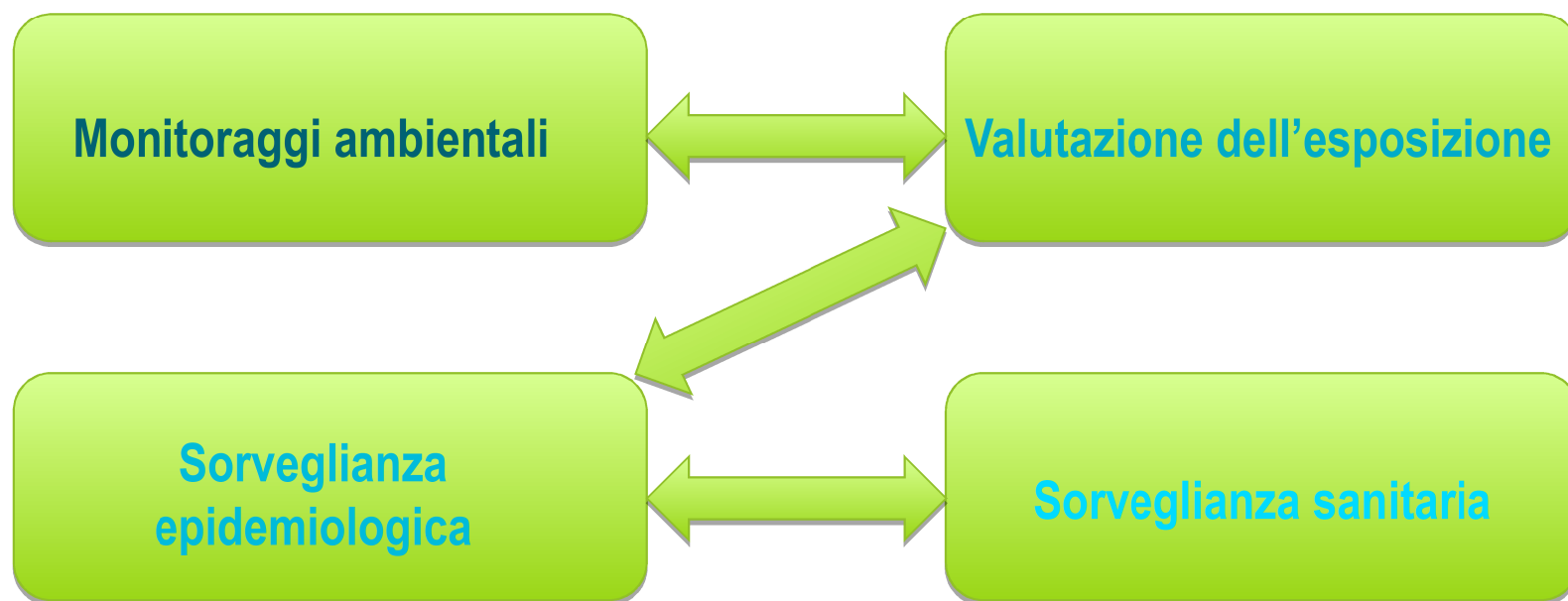
Esiste un'associazione causale?

Valutare gli effetti sanitari delle emissioni in coorti di residenti in aree industriali

Disegno dello studio – studio di coorte residenziale

Geocoding procedure

Municipality data

Study area definition

Distance from other industrial sites

Socioeconomic level

Pollution source

Dispersion model (footprint)

Occupational history

Population cohort

t_0 Follow-up t_1

Epidemiological evaluation

Exposure-response relationship

Meteorology

Other pollution sources

Orography

Environmental monitoring

Source: Ancona et al. Epidemiologia & Prevenzione 2014

Study Area and Population
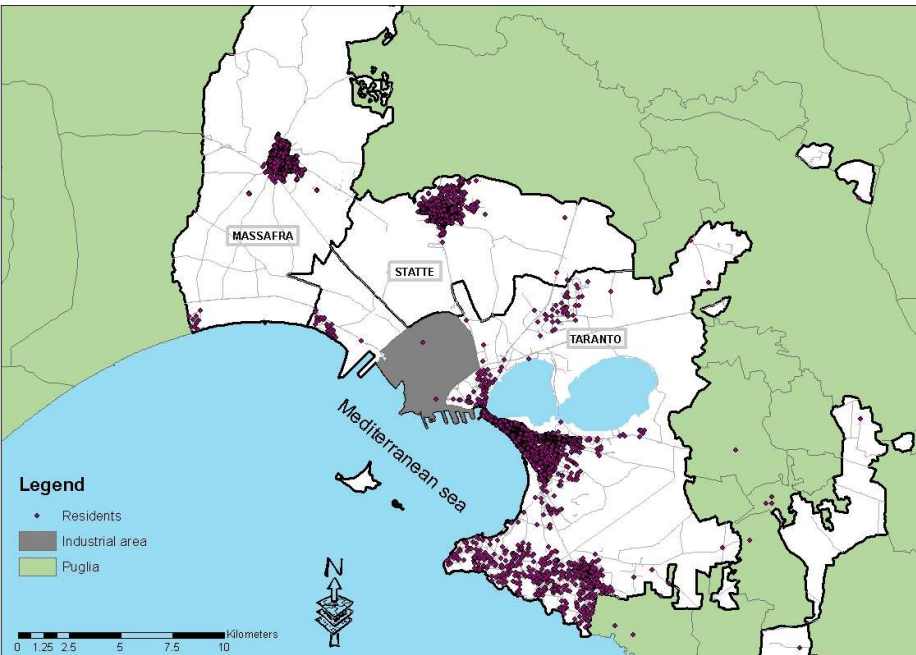
Taranto, Statte e Massafra: 321.000 subjects
Follow up: 1998-2013
Exposure since 1965: PM_{10} e SO_2 from steel plant
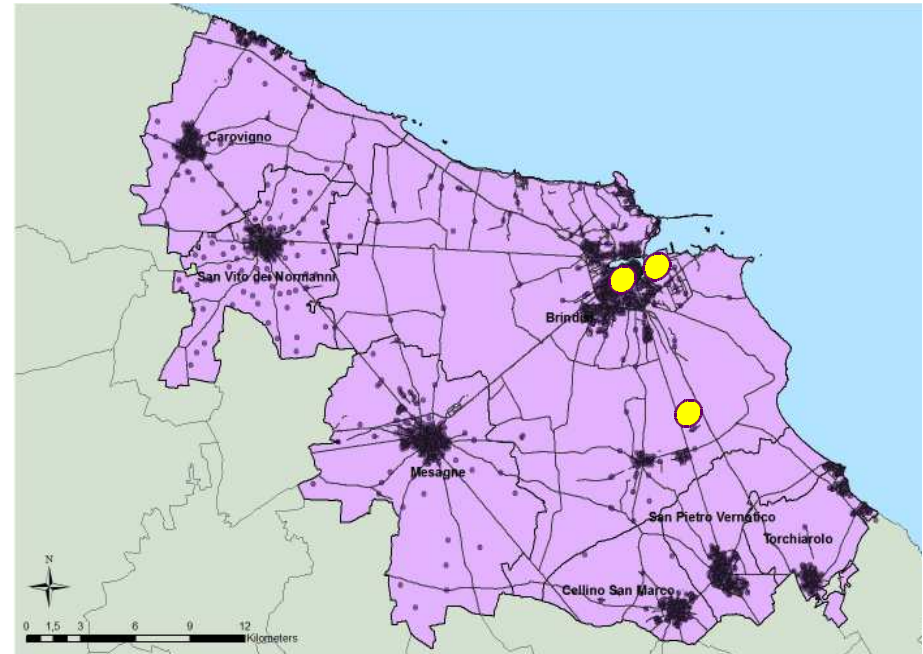
Brindisi and 7 municipalities : 224.000 subjects
Follow up 2000 to 2013
Exposure, since 1991: PM_{10} e SO_2 power plants e COV petrochemical plant

The socio-economic position (SEP)

	Brindisi	Taranto
N	219.837	311.039
SEP	%	%
alto	11	22
medio alto	23	13
medio	28	11
medio basso	**23**	**19**
basso	**15**	**36**

By census block level:
- % of population with educational level equal to or less than primary school,
- % of the active population unemployed or looking for their first job,
- % of rented houses,
- % of single parent families,
- population density
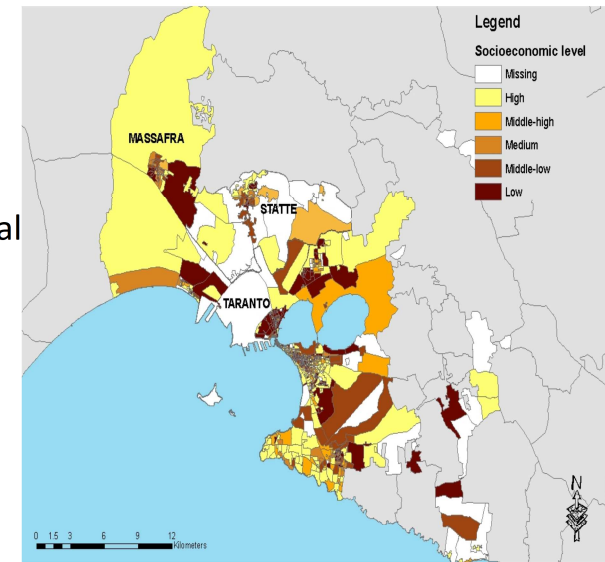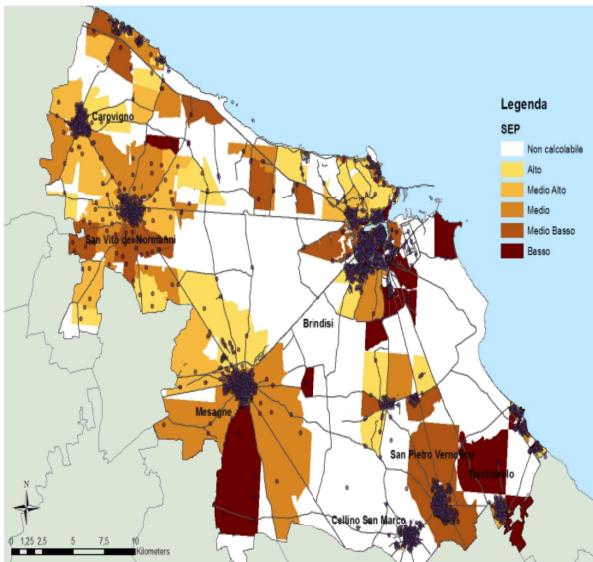
Statistical analysis

Cox proportional hazard model

PM$_{10}$ and SO$_2$ concentrations from plants

Outcomes

Age

Gender

Calendar period

Birth place

Socioeconomic position

Occupational category

Regional health database mortality hospital discharge admission records, cancer registry
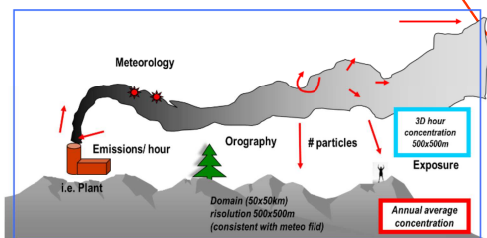
Main analysis Taranto:
- current exposure (lag 0, average exposure in the current year),
- 5-year time-window lagged concentrations over the period considered

Main analysis Brindisi:
- fixed exposure (1997) Hospitalization:
- Current exposure (lag 0)
- Stratified analysis over three period

Taranto PM$_{10}$ and SO$_2$ exposure
ARPA dispersion model – 2010
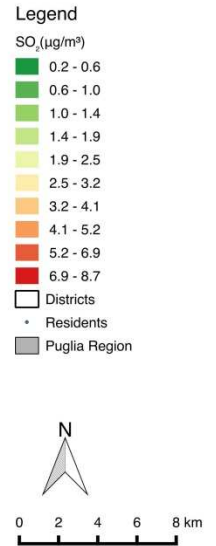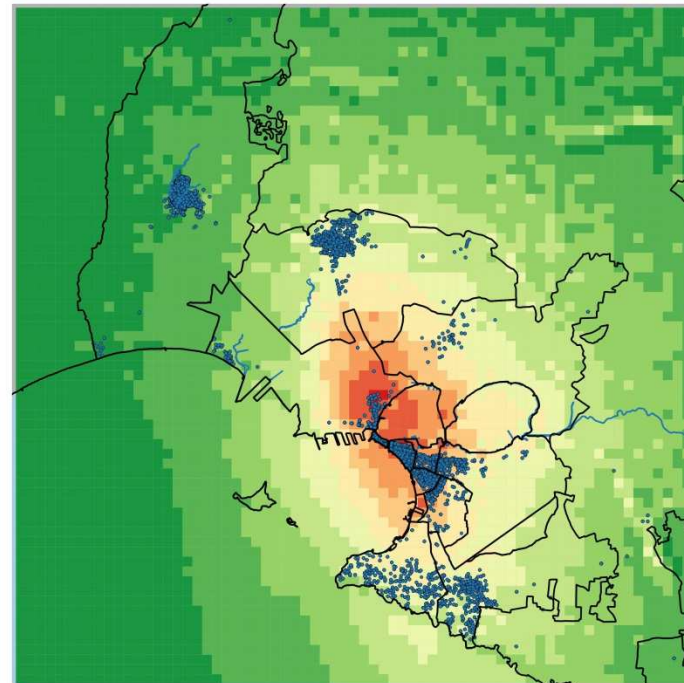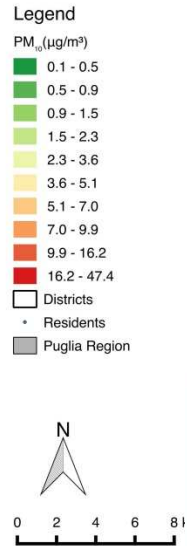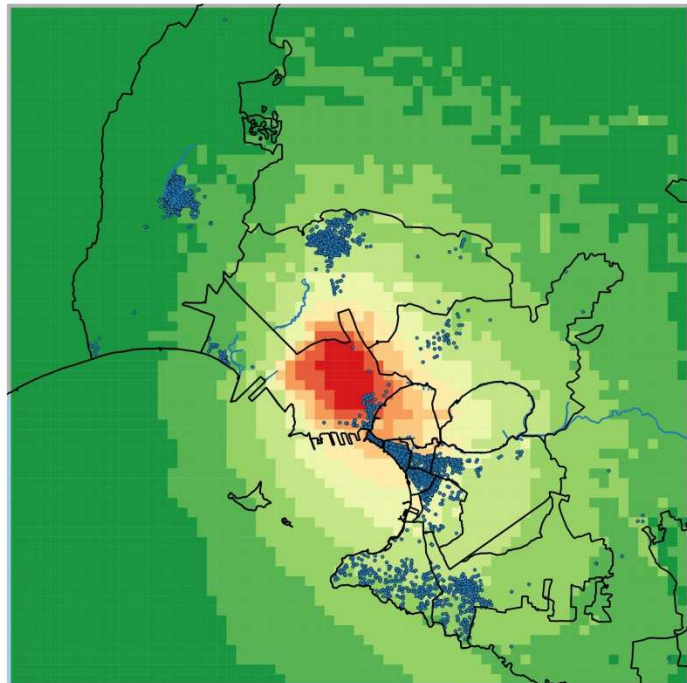
Temporal trend of the steel productivity, emissions and pollutants concentrations at lag 0, study period 1965-2013
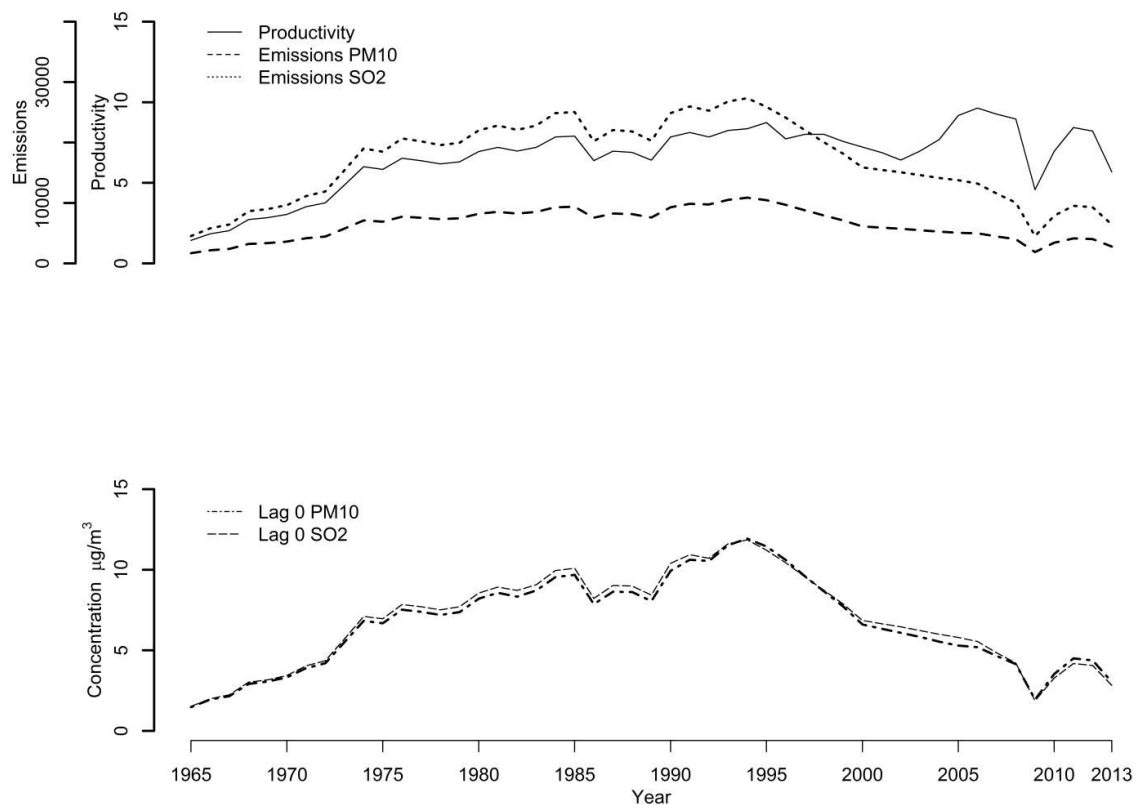
annual average exposure at lag 0 at baseline (1998)

Pollutant	Mean	SD	Min	Max	Percentiles				
					5°	25°	50°	75°	95°
PM_{10} (µg/m3)	9.03	9.53	0	85.24	1.05	3.52	7.79	9.35	30.60
SO_2 (µg/m3)	9.09	4.81	0	22.08	1.88	5.53	9.27	11.82	18.18

Studio di coorte dei residenti a Taranto: risultati

L'esposizione a PM_{10} e SO_2 (incrementi di 10 µg/m³) di origine industriale è associata ad un aumento della **mortalità** per cause naturali, tumori, malattie cardiovascolari e renali. Popolazione Totale (M+F). Anni 1998-2013

Causa di decesso	PM_{10}			SO_2		
	HR	95%IC		HR	95%IC	
Cause naturali	1.04	1.02	1.06	1.09	1.05	1.12
Tumori maligni	1.03	1.00	1.06	1.08	1.02	1.15
Trachea, bronchi e polmoni	1.05	0.99	1.12	1.17	1.03	1.34
Malattie cardiovascolari	1.02	1.00	1.05	1.04	0.99	1.10
Malattie cardiache	1.05	1.02	1.09	1.11	1.04	1.18
Eventi coronarici acuti	1.10	1.02	1.19	1.29	1.10	1.52
Malattie renali	1.13	1.02	1.25	1.16	0.93	1.45

Esame della latenza degli effetti sulla mortalità
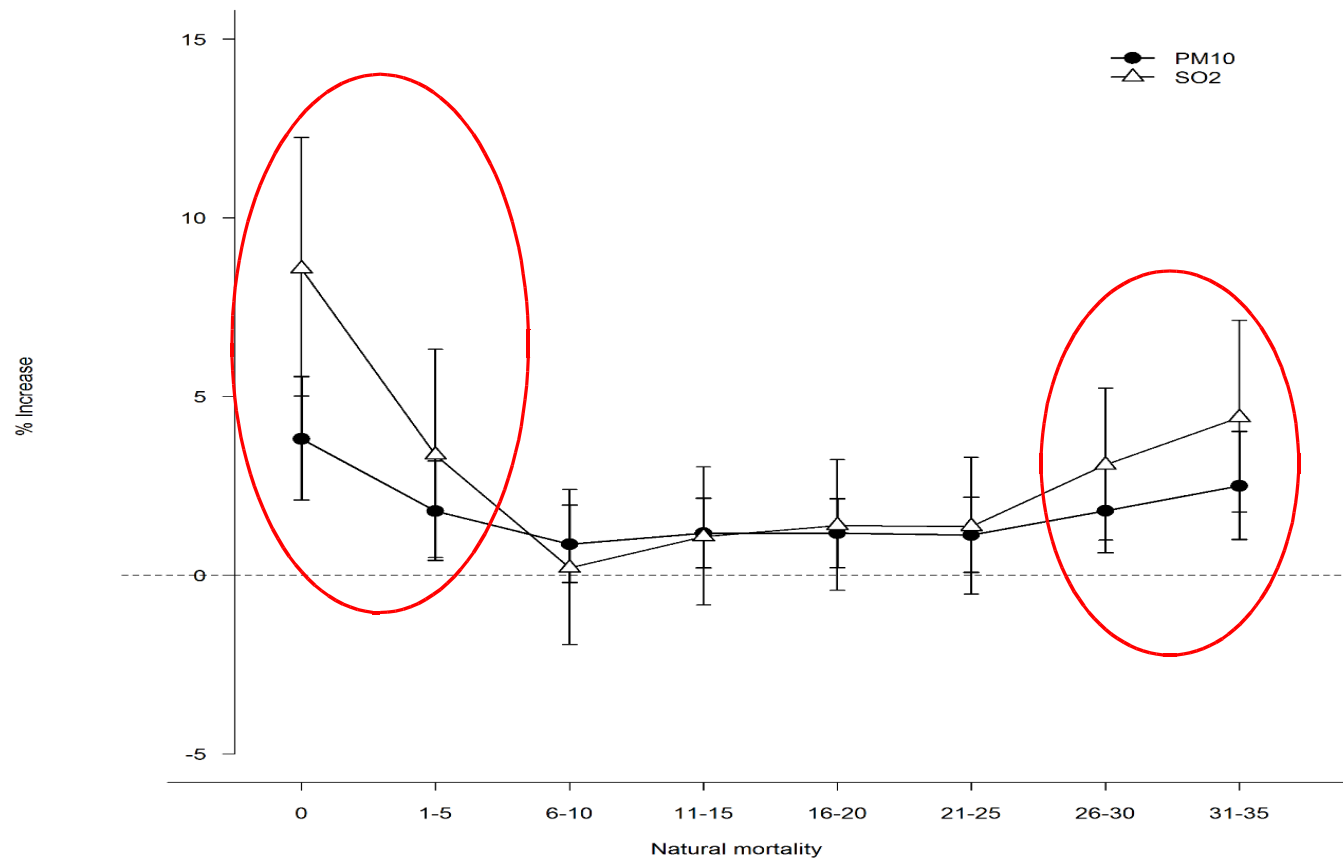
Penalized splines and confidence intervals (95%CI) of the relationship between annual exposure to industrial PM_{10} at lag 0 and natural mortality, mortality from malignant neoplasms, from lung cancer, heart diseases, acute myocardial infarction and kidney diseases
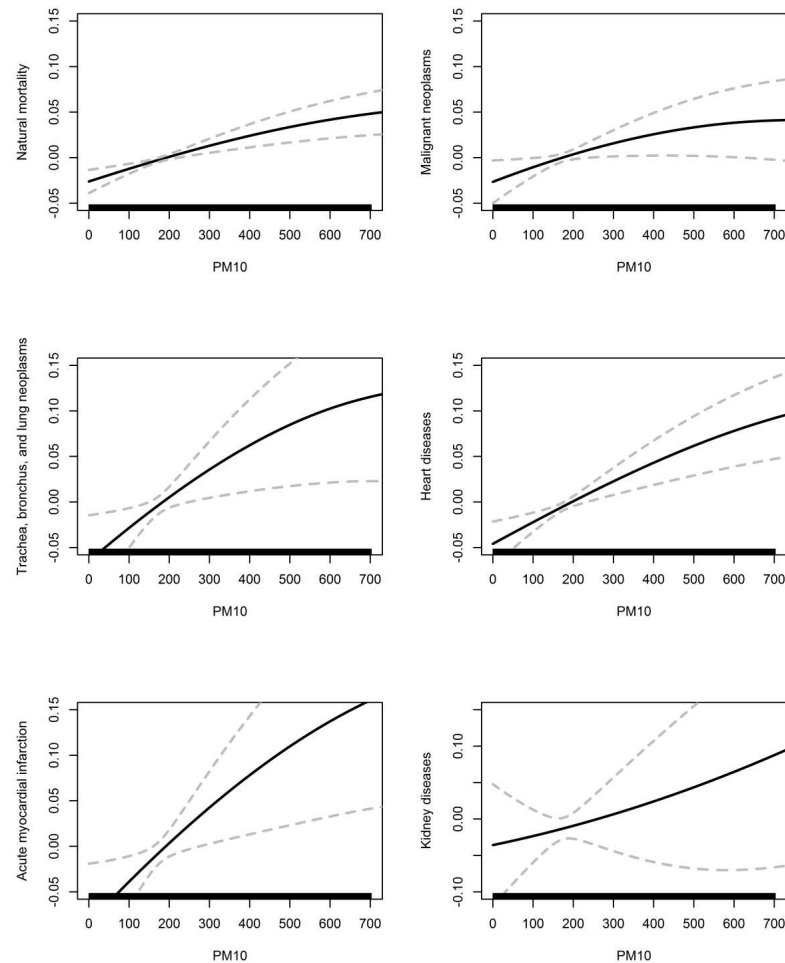
Associazione tra esposizione a PM_{10} e SO_2 industriali ed **ospedalizzazione**. Rischio relativo (HR) per incrementi di 10 μg/m³ - Popolazione totale (Uomini + Donne), 1998-2014.

Diagnosi	PM_{10}			SO_2		
	HR	95%IC		HR	95%IC	
Malattie neurologiche	1.05	1.01	1.08	1.21	1.13	1.30
Malattie cardiovascolari	1.04	1.02	1.05	1.06	1.03	1.09
Malattie cardiache	1.05	1.04	1.07	1.10	1.07	1.14
Eventi coronarici acuti	1.02	0.99	1.06	1.14	1.06	1.23
Scompenso cardiaco	1.02	0.99	1.06	1.13	1.06	1.21
Malattie dell'apparato respiratorio	1.07	1.05	1.08	1.15	1.12	1.19
Infezioni delle vie respiratorie	1.11	1.08	1.13	1.35	1.28	1.42
Malattie dell'apparato digerente	1.04	1.03	1.05	1.08	1.05	1.11
Malattie renali	1.08	1.05	1.11	1.09	1.04	1.15
Gravidanza con esito abortivo	1.02	0.98	1.07	1.16	1.06	1.27
Bambini 0-14 anni						
Malattie respiratorie	1.11	1.09	1.14	1.33	1.26	1.41
Infezioni delle vie respiratorie	1.15	1.11	1.18	1.49	1.39	1.59

Associazione tra esposizione a PM_{10} e SO_2 industriali ed **incidenza di tumore**. Rischio relativo (HR) per incrementi di 10 µg/m^3 - Popolazione totale (Uomini + Donne), 2006-2011.

Sede del tumore	N	PM$_{10}$			SO$_2$		
		HR*	95% IC		HR*	95% IC	
Tutti i tumori	8999	**1.14**	**1.09**	**1.19**	1.05	0.97	1.14
VADS	144	0.80	0.52	1.23	0.67	0.34	1.31
Esofago	27	0.30	0.06	1.48	0.20	0.04	1.08
Stomaco	284	0.99	0.77	1.28	0.69	0.43	1.11
Colon-retto	887	1.11	0.96	1.28	1.00	0.77	1.31
Fegato	340	1.10	0.89	1.37	0.75	0.48	1.15
Colecisti e vie biliari	117	1.14	0.80	1.64	0.88	0.41	1.85
Pancreas	208	1.19	0.90	1.58	1.19	0.68	2.08
Laringe	91	1.39	0.99	1.96	1.39	0.62	3.13
Polmoni	943	**1.29**	**1.14**	**1.45**	**1.42**	**1.10**	**1.84**
Pleura	89	0.96	0.61	1.52	1.15	0.50	2.64
Osso	22	0.59	0.16	2.22	0.53	0.09	2.96
Cute	1944	**1.15**	**1.04**	**1.26**	1.08	0.90	1.30
Tessuti	40	1.22	0.66	2.27	0.62	0.17	2.26
Mammella	1137	**1.27**	**1.13**	**1.41**	1.19	0.94	1.51
Prostata	653	1.09	0.92	1.29	1.06	0.77	1.45
Testicolo	42	1.08	0.58	2.01	0.96	0.30	3.11
Rene	173	**1.32**	**1.01**	**1.73**	**2.44**	**1.38**	**4.34**
Pelvi e vie urinarie	34	0.87	0.34	2.23	0.56	0.13	2.46
Vescica	415	1.07	0.88	1.32	0.91	0.61	1.35
Sistema nervoso centrale	117	1.23	0.87	1.72	0.87	0.42	1.82
Tiroide	365	0.97	0.75	1.25	0.76	0.49	1.17
Mesotelioma	72	0.96	0.57	1.60	0.93	0.36	2.37
Sarcoma di Kaposi	38	1.35	0.77	2.37	1.39	0.41	4.64
Linfoma di Hodgkin	52	0.98	0.54	1.78	1.56	0.54	4.50
Linfoma non-Hodgkin	31	0.93	0.41	2.11	0.74	0.18	3.06
Mieloma	98	0.91	0.56	1.46	0.76	0.34	1.69
Leucemie	184	1.11	0.82	1.51	1.21	0.68	2.15

*Hazard Ratio (HR) da modello di Cox stratificato per periodo di follow-up (tre classi) e sesso, età (asse temporale), aggiustato per stato socieconomico ed occupazione

DIFFERENCES IN DIFFERENCES: relazione tra le variazioni

nelle concentrazioni di PM10 e variazioni di mortalità nel periodo 2008-2014
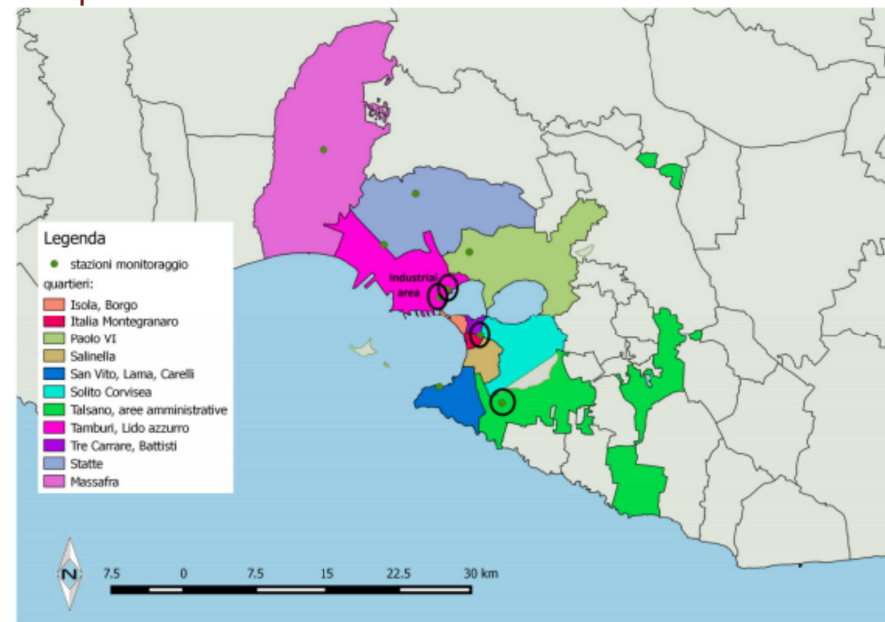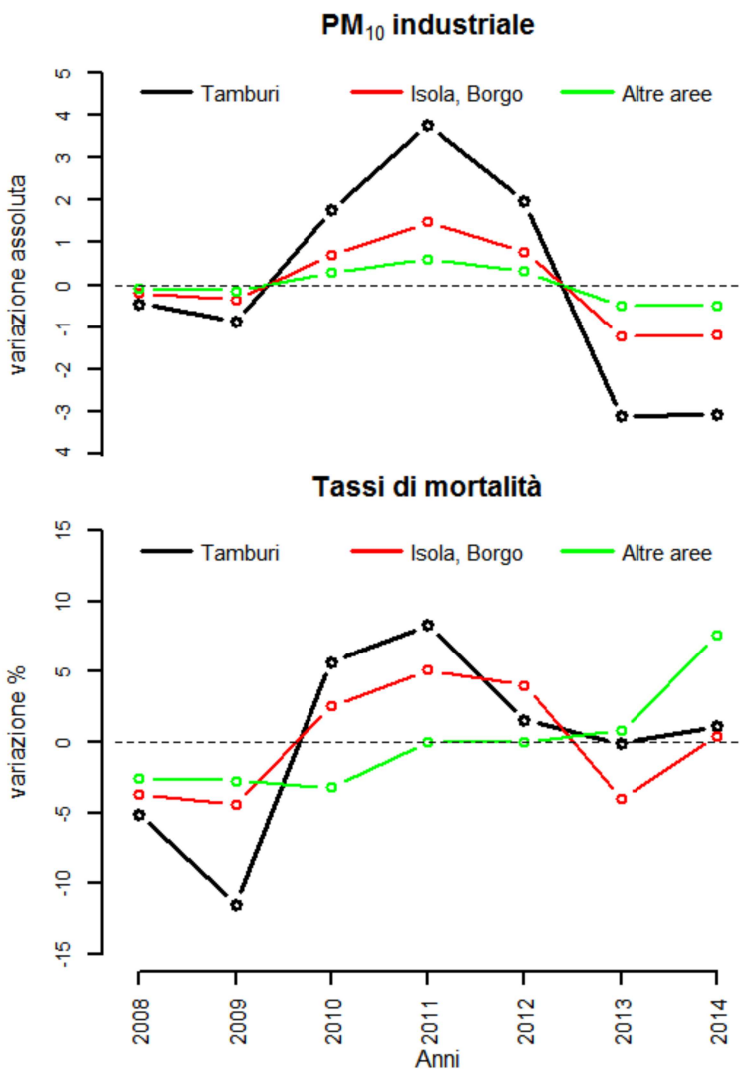
Numero di decessi, incremento percentuale del rischio (IC95%), relativo a 1 µg/m3 di variazione di PM10 industriale, 2008-2014.

Cause di morte (ICD- 9CM)	n.	I.R.%	I.C. 95%	
Cause naturali (001-799)	15303	1.86	-0.06	3.83
Malattie del sistema circolatorio (390-459)	5721	0.70	-2.35	3.84
Malattie cardiache (390-429)	4346	1.91	-1.55	5.50
Malattie del sistema respiratorio (460-519)	1150	8.74	1.50	16.51

Study popolation - Brindisi

223.934 people
(2000-2013)

Occupational categories

Ever worked	83240	*37.2*
Services industry	27641	*12.3*
Agricolture	33144	*14.8*
Constructions industry	10109	*4.5*
Naval and Mechanical constructions	9270	*4.1*
Chemical-Pharmacutical-Rubber	4343	*1.9*
Plastic	3098	*1.4*
Transports		
Electric construction		
Aeronautic		
Mineral processing		
Gas and power industries		
Iron and steel industry		
Dock worker		
Others	4564	*2.0*

Socio-economic position (SEP)

High	23484	*10.5*
Middle-high	50647	*22.6*
Middle	62155	*27.8*
Middle-low	50671	*22.6*
Low	32880	*14.7*
Not found	4097	*1.8*

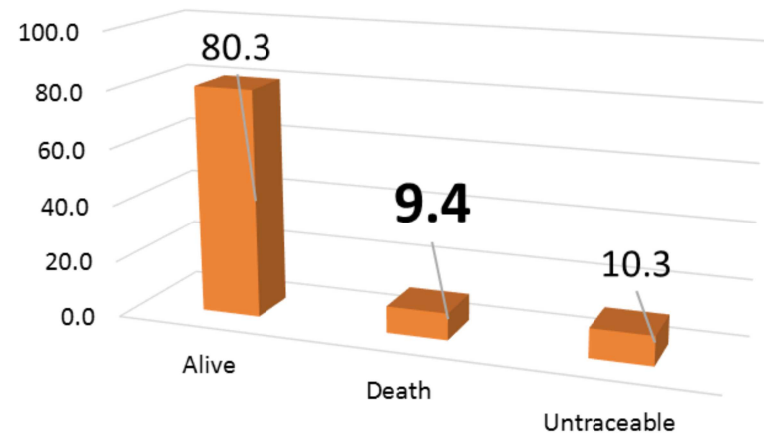• % population with educational level <= primary school
• % active population unemployed or looking for their first j[...]
• % rented houses
• % single parent fami[...]
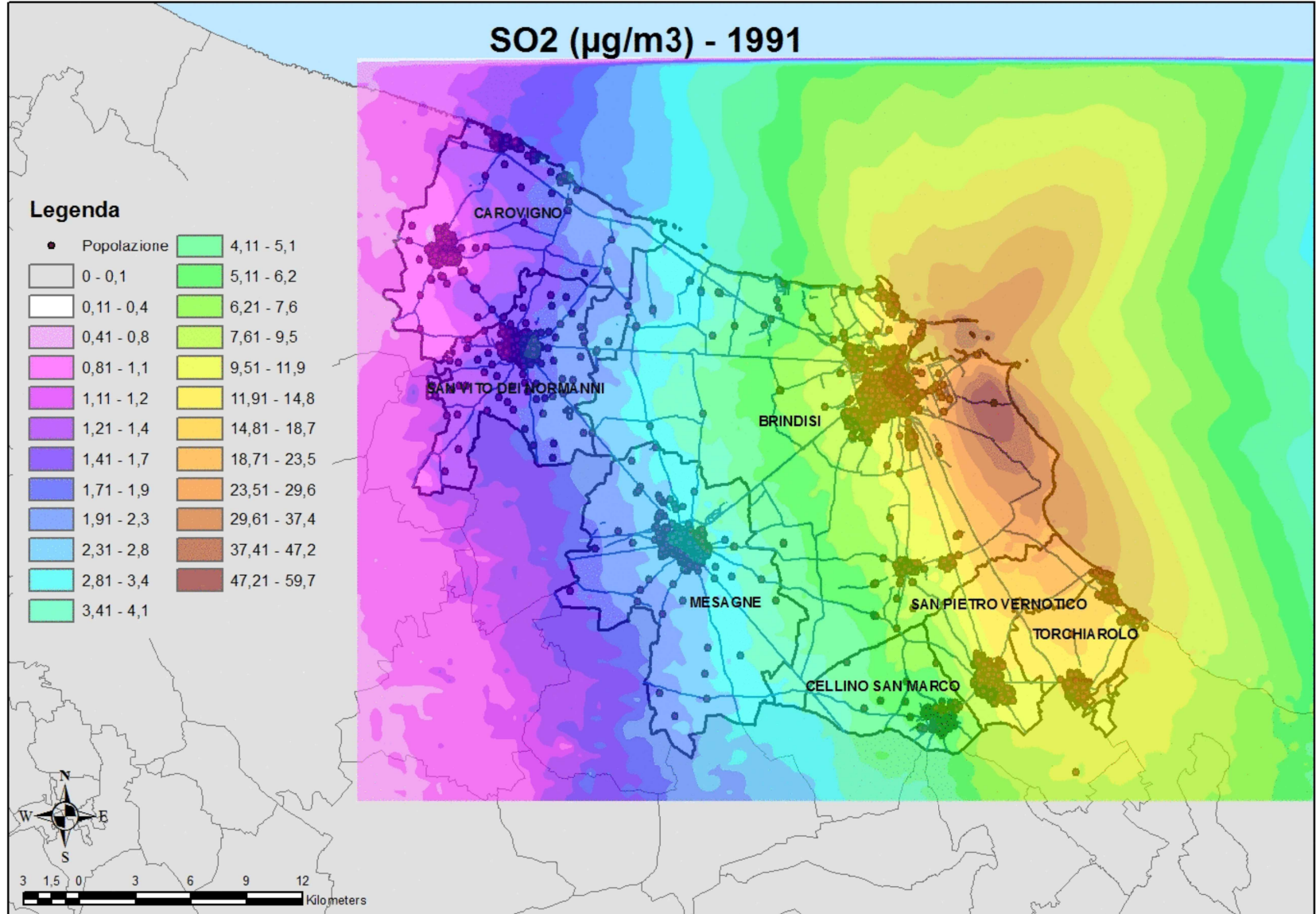• population density

Legend
SEP
- Not found
- High
- Middle-high
- Middle
- Middle-low
- Low

Vital status at 31-12-2013

Alive	Death	Untraceable
80.3	9.4	10.3

SO$_2$ concentrations from power plants

Exposure Brindisi area

Emission of SO$_2$ (tonn/year) from power plants

	mean	sd	5th	25th	50th	75th	90th	95th
1991	8.568	5.565	1.079	2.751	9.806	13.350	15.450	17.080
1997	8.005	5.167	1.022	2.607	9.362	12.290	14.350	15.780
2013	0.301	0.251	0.061	0.145	0.291	0.341	0.572	0.685

SO$_2$- Popolation weighted exposure (µg/m^3)
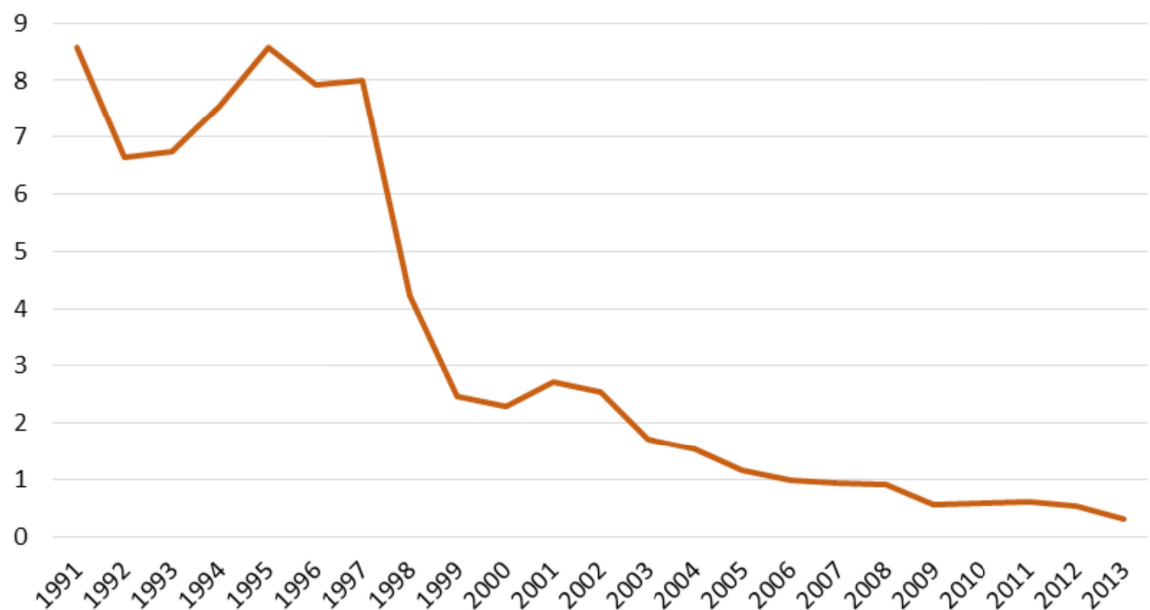
Population weighted exposure PM$_{10}$ and SO$_2$ (μg/m3)
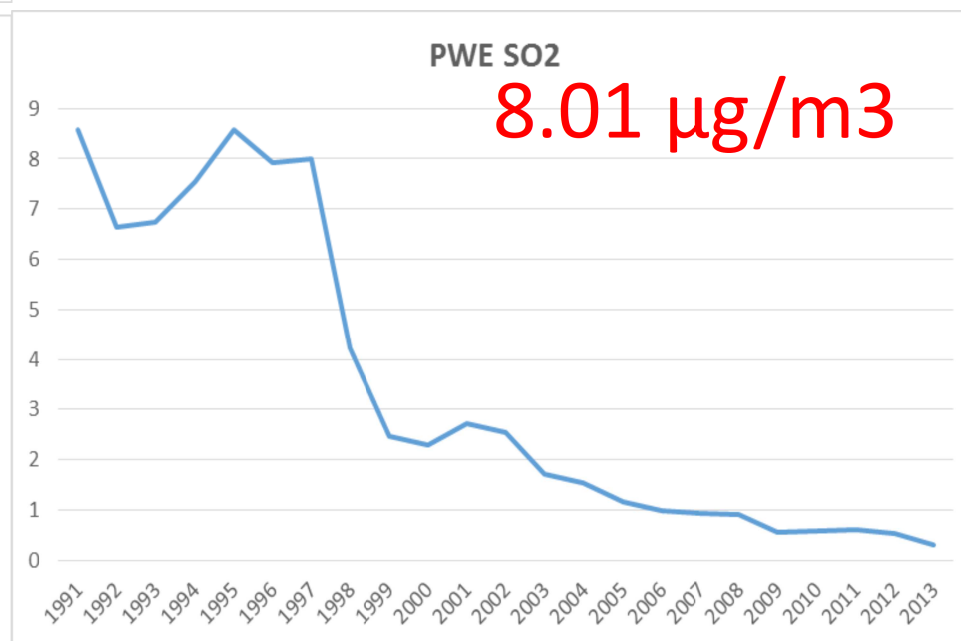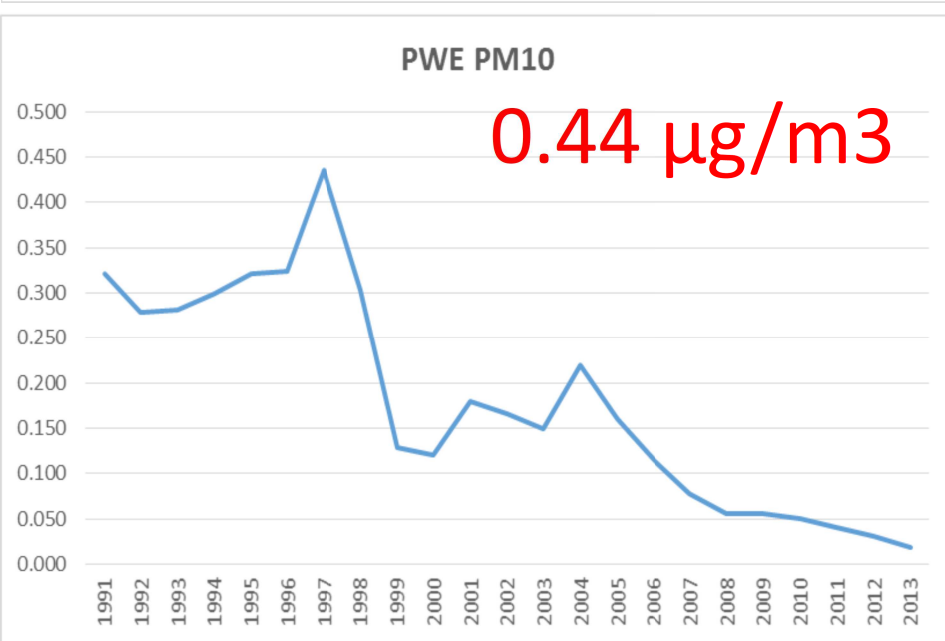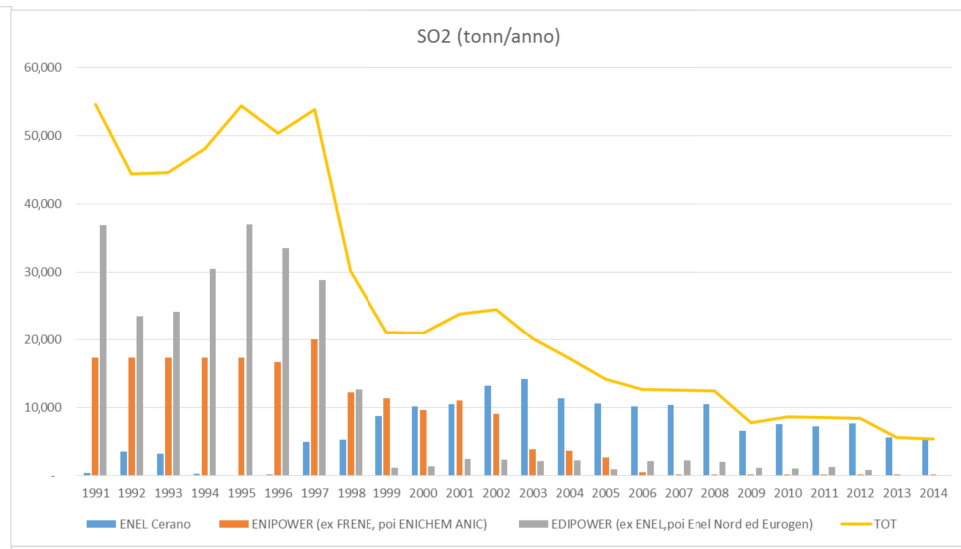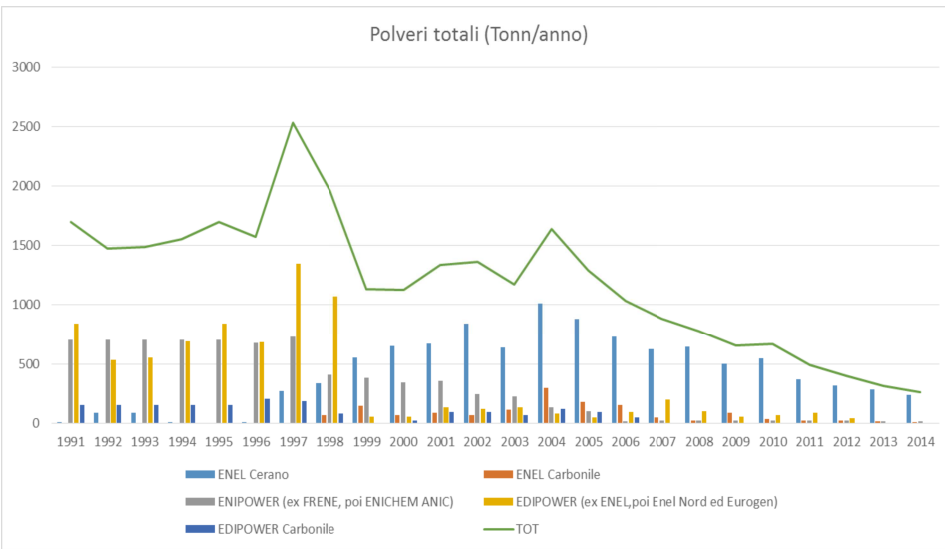
Association between PM$_{10}$ and SO$_2$ from power plants and cause-specific mortality (2000-2013). Adjusted hazard ratios (HRs and 95% CI)

Cause of death	Power plants						
		Exposure 1997 PM$_{10}$ (95°p - 5°p = 0.967)			Exposure 1997 SO$_2$ (95°p - 5°p = 14.758)		
	N	HR*	Low	Up	HR*	Low	Up
Natural mortality	19653	1,01	0,96	1,05	1,00	0,96	1,05
Malignant neoplasms	5375	**1,05**	**1,01**	**1,08**	**1,15**	**1,05**	**1,25**
Stomach	229	0,83	0,53	1,29	0,93	0,61	1,42
Colon	484	1,01	0,80	1,29	0,98	0,73	1,30
Liver	400	1,04	0,89	1,21	1,02	0,74	1,40
Pancreas	267	**1,07**	**0,99**	**1,16**	**1,55**	**1,04**	**2,29**
Larynx	53	0,91	0,37	2,25	0,80	0,33	1,93
Trachea, bronchus, and lung	1103	1,05	0,97	1,13	1,14	0,94	1,38
Pleura	41	1,06	0,82	1,37	1,08	0,38	3,10
Breast	305	1,05	0,92	1,19	1,19	0,83	1,73
Bladder	209	1,09	0,98	1,21	1,52	0,98	2,36
Kidney	98	1,05	0,82	1,36	1,12	0,59	2,15
Brain and other parts of nervous s	214	0,98	0,64	1,51	1,08	0,69	1,67
Lymphatic and hematopoietic tissu	427	1,05	0,96	1,15	1,21	0,89	1,64
Leukaemia	185	1,05	0,93	1,19	1,29	0,81	2,05
Neurological diseases	642	0,85	0,65	1,11	0,89	0,69	1,14
Cardiovascular diseases	7695	0,87	0,81	0,94	0,88	0,82	0,94
Cardiac diseases	5417	0,94	0,86	1,03	0,95	0,87	1,03
Ischemic diseases	1795	1,00	0,87	1,16	0,97	0,83	1,12
Acute coronaric events	530	1,07	0,98	1,16	1,24	0,94	1,63
Respiratory diseases	1590	**1,08**	**1,02**	**1,15**	**1,22**	**1,04**	**1,43**
Respiratory infections	324	0,94	0,65	1,36	0,97	0,68	1,37
COPD	867	**1,08**	**0,99**	**1,18**	1,19	0,96	1,47
Kidney disease	398	0,76	0,54	1,07	0,75	0,54	1,03

*Hazard Ratio (HR) stratified by follow-up period (3 classes) and gender and adjusted for age (temporal axis), SEP, region of birth, occupation

Association between PM$_{10}$ and SO$_2$ from power plants and cancer incidence (2006-2010). Adjusted hazard ratios (HRs and 95% CI)

SITES	POLO ENERGETICO						
		Exposure 1997 PM$_{10}$ (95°p - 5°p = 0.967)			Exposure 1997 SO$_2$ (95°p - 5°p = 14.758)		
	N	HR*	Low	Up	HR*	Low	Up
All sites	5183	1,03	0,98	1,07	1,09	0,99	1,19
Stomach	159	0,91	0,54	1,54	1,02	0,61	1,70
Colon-rectus	496	0,79	0,58	1,07	0,80	0,59	1,06
Liver	137	1,07	0,96	1,20	1,52	0,89	2,60
Pancreas	102	1,08	0,96	1,20	1,79	0,95	3,38
Lung	508	1,06	0,98	1,15	**1,38**	**1,05**	**1,83**
Skin	1254	1,04	0,97	1,11	1,15	0,96	1,38
Breast	640	1,03	0,94	1,14	1,15	0,88	1,48
Prostate	385	0,84	0,60	1,18	0,78	0,56	1,08
Kidney	100	1,03	0,78	1,35	1,01	0,53	1,92
Bladder	197	0,98	0,64	1,51	1,08	0,68	1,69
Central Nervous System	88	1,06	0,90	1,26	1,53	0,77	3,04
Thyroid	196	0,70	0,43	1,14	0,72	0,45	1,14
Lymphatic and hematopoietic tissue	263	1,06	0,97	1,16	1,33	0,89	1,98
Myeloma	59	1,08	0,96	1,21	**2,82**	**1,22**	**6,51**
Leukaemia	129	0,89	0,50	1,60	0,87	0,49	1,53

*Hazard Ratio (HR) stratified by follow-up period (3 classes) and gender and adjusted for age (temporal axis), SEP, region of birth, occupation

Conclusion

In both industrial areas, estimated exposures to industrial PM_{10} and SO_2 were associated with several health outcomes, adjusting for SEP and occupational exposures, confirming that industrial air pollution is an important risk factor for the health status of residents

Focusing on Taranto, when we considered time-lags, increased mortality risks have been found associated with estimated concentration of PM_{10} and SO_2 both for the most recent five years of exposure and for the far past (more than 25 years before the current exposure).

Strengths and limitations

<div style="border: green solid">

- Residential cohort approach

- Cohort size

- Dispersion models

- A priori approach

- Occupational exposure and SEP

</div>

<div style="border: red solid">

- Pollutant levels estimated only at the baseline addresses

- Concomitant environmental exposure

- Uncertainity in exposure estimates

- Unknown or unmeasured lifestyle confounders

</div>

Ulteriori risorse disponibili:
- Dati individuali sulle cronicità
- Censimento ISTAT 2011