LA SORVEGLIANZA EPIDEMIOLOGICA E LE VALUTAZIONI DI IMPATTO SANITARIO

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Health surveillance

"The continued watchfulness over the distribution and trends in the incidence of disease through the systematic collection, consolidation and evaluation of morbidity and mortality reports and other relevant data"

Alexander Langmuir, Chief Epidemiologist, CDC

"Continuous analysis, interpretation and feedback of systematically collected data, generally using methods distinguished by their practicality, uniformity and rapidity, rather than by accuracy and completeness"

WJ Eylenbosch & ND Noah (eds). Surveillance in Health and Disease. Oxford University Press 1988.

"The systematic ongoing collection, collation and analysis of data for public health purposes and the timely dissemination of public health information for assessment and public health response as necessary."

World Health Assembly 2005

Indicators for Environmental health

Environmental domain

- Environmental quality indicators
- Proxy indicators (eg distance to.., intensity of ..)

Health domain

- Physiological parameters and body burden
- Health effects indicators: incidence/ prevalence disease, attributable morbidity, mortality burden (eg excess mortality during heat waves)
- Summary health indicators : disease burden (DALYS), years of life lost (YLL), loss of life expectancy (LLE)

Policy domain

- Indicators describing the implementation of policy measures
- Composite indicators (eg economic, sustainability index)

Da cosa dipendono le variazioni nei tassi di mortalità?

- Denominatori di popolazione (accuratezza nelle stime, differenze di età)
- Differenze etniche-genetiche
- Differenze sociali
- Differenze nelle abitudini di vita (fumo, alcol, etc)
- Differenze nelle esposizioni ambientali ed occupazionali
- Differenze nella qualità delle cure
- Differenze nelle abitudini diagnostiche

Da cosa dipendono le variazioni nei tassi di incidenza/prevalenza?

- Come sopra

Più

- Differenze nella offerta diagnostica
- Differenze nella offerta assistenziale

La fallacia del cecchino texano!

I dati mi dicono che ho ragione!!

ristora
CORTADO

Libero

CAPSULE
GOURMET
ristora

Lunedì 19 novembre 2018 € 1,50*
DIRETTORE VITTORIO FELTRI

Nella Milano inquinata si campa tanto

SE C'È SMOG SI VIVE DI PIÚ

Lombardia e Nordest sono tra le aree europee a più alta concentrazione di pm10. Ma si muore a 84 anni tre in più della media Ue. A Bolzano aria pessima: però guida la classifica delle città dove si sta meglio

Esempi Italiani

- **Sentieri** described the health profile of populations living in contaminated sites.[1]
- **EpiAir** provided methods and criteria for epidemiological surveillance of the health impact of air pollution in large Italian cities.[2]
- **Moniter** dealt with incinerator risks.[3]
- **Mesothelioma monitoring,** aimed at detection of asbestos exposure, led to identification of new type of asbestiform fiber in Biancavilla, Sicily

1. http://www.iss.it/epam/index.php?id=387&tipo=11&lang=1
2. http://www.epiair.it/
3. http://www.arpa.emr.it/moniter/

Mortality at municipality level, 44 contaminated sites in Italy

Mortality (63 causes of death 1995-2002)

Standardized mortality Ratios, SMR),reference regional population

Crude SMRs and adjusted by deprivation index

Epidemiologia e Prevenzione, 2011

Mortality Taranto area,1995-2002, reference Puglia region.Men

Cause of death	*OSS*	*SMR (IC 90)*	*SMR ID (IC 90)*
All causes	7585	109 (107-111)	107 (105-109)
All cancer	2529	115 (112-119)	113 (109-116)
Lung cancer	840	130 (122-137)	119 (112-126)
Pleural cancer	83	521 (430-625)	293 (242-352)
Circulatory diseases	2654	105 (102-108)	103 (99-106)
Ischemic heart disease	1032	123 (117-129)	112 (107-118)
Respiratory diseases	666	107 (100-114)	107 (100-114)
Acute respiratory diseases	125	156 (134-181)	149 (127-173)

SMR ID= Standardized Mortality Rates adjusted for deprivation index

Aggregated study: can we tell that the steel industry is causing increased mortality?

G. Taubes, Science, 1995

SPECIAL NEWS REPORT

Epidemiology Faces Its Limits

The search for subtle links between diet, lifestyle, or environmental factors and disease is an unending source of fear—but often yields little certainty

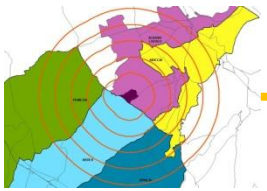
"People don't take us seriously ... and when they do ... we may unintentionally do more harm than good."
—Dimitrios Trichopoulos

"We're pushing the edge of what can be done with epidemiology."
—Ken Rothmai

"People [may] think they have been able to control for things that are inherently not controllable."
—Norman Breslow

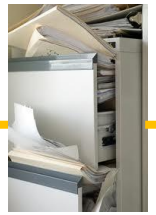
"The sin comes in believing a causal hypothesis is true because your study came up with a positive result."
—Sander Greenland

Study design – cohort study

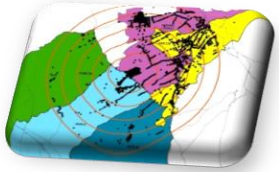


Study area definition

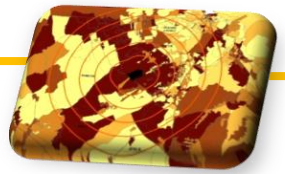
Municipality data



Geocoding procedure



Socioeconomic level



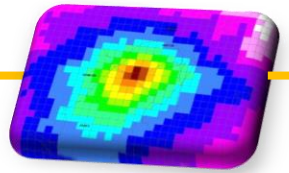
Occupational history

Follow-up

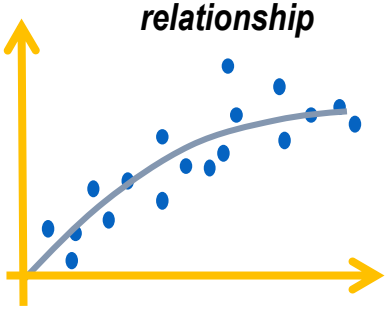
Epidemiological evaluation

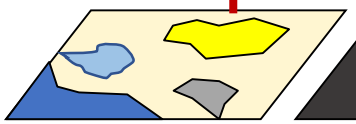
Pollution source

Dispersion model (footprint)



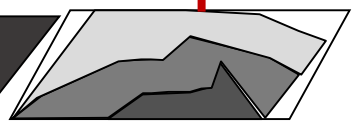
Exposure-response relationship





Meteorology

Other pollution sources



Orography

Environmental monitoring

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Industrial air pollution and mortality in the Taranto area, Southern Italy: A difference-in-differences approach

Simona Leogrande[a], Ester Rita Alessandrini[b], Massimo Stafoggia[b,*], Angela Morabito[c], Alessandra Nocioni[c], Carla Ancona[b], Lucia Bisceglia[d], Francesca Mataloni[b], Roberto Giua[c], Antonia Mincuzzi[a], Sante Minerba[a], Stefano Spagnolo[c], Tiziano Pastore[c], Annalisa Tanzarella[c], Giorgio Assennato[c], Francesco Forastiere[b,e,f], , on behalf of the CSA Puglia Study Group (see

Production

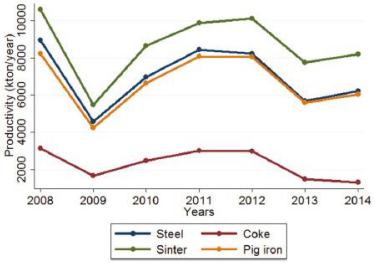
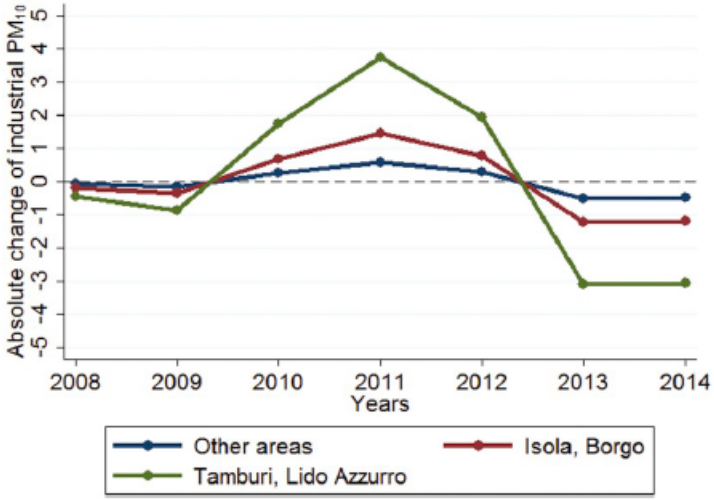


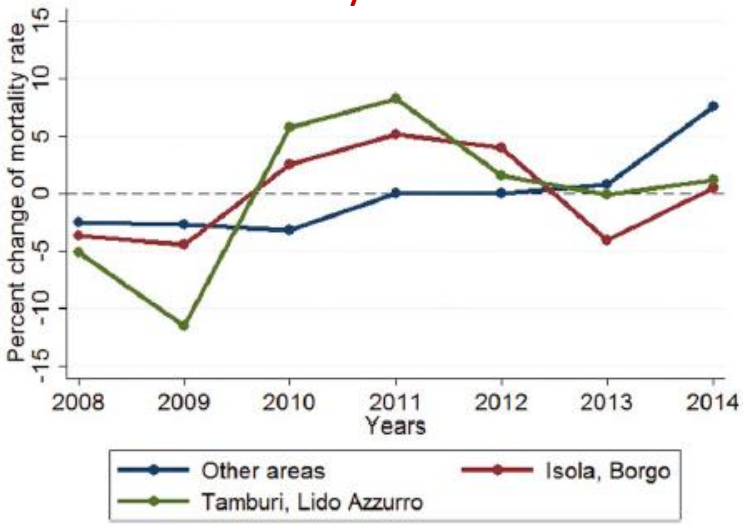
Fig. 3. Productivity (kton/year) of the "ILVA" Steel Plant by year and type of product.

Exposure



Absolute change of population weighed exposure to industrial PM_{10} by

Mortality



g. 6. Percent change of natural mortality rate (per 1000 person-years) by year

OBIETTIVI

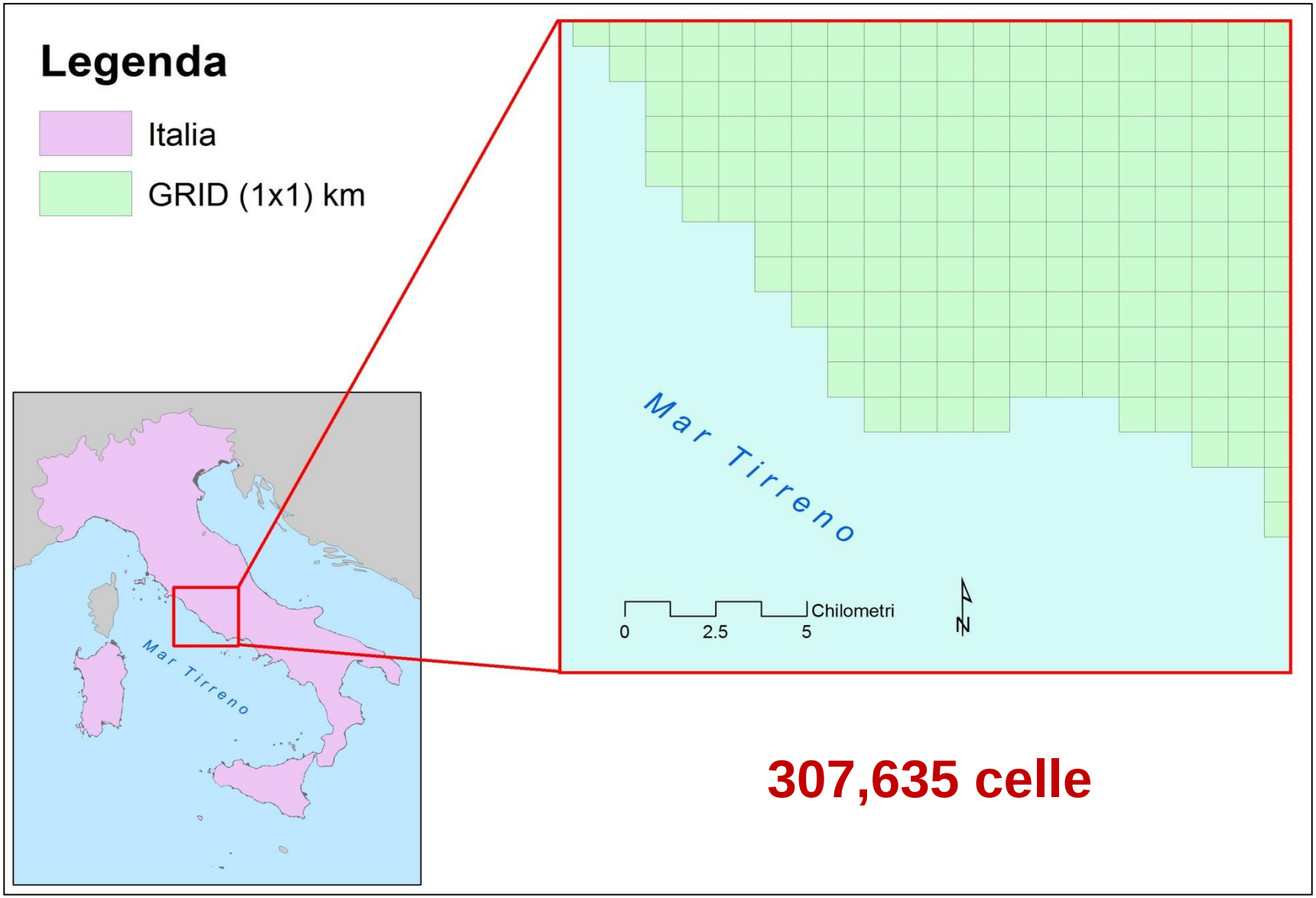
- Costruire un database nazionale con parametri spaziali e spazio-temporali per descrivere e stimare esposizioni ambientali multiple in Italia

- Stimare le concentrazioni giornaliere di PM_{10} e $PM_{2.5}$ su una griglia di 1 km^2 per l'intera Italia, per il periodo 2006-2015, usando molteplici fonti di dati, tra cui i dati satellitari

PROGETTO BEEP

- Durata: 2 anni
- Partner
  - CNR-IBIM Palermo
  - DEP LAZIO Roma
  - INAIL
  - ARPA Emilia Romagna
  - SSR Emilia Romagna
  - CPO Torino
  - CNR-IPCF Pisa
  - ARES Puglia
  - DASOE Palermo
  - CNR-ISAC Roma

GRIGLIA DI CELLE 1-KM^2



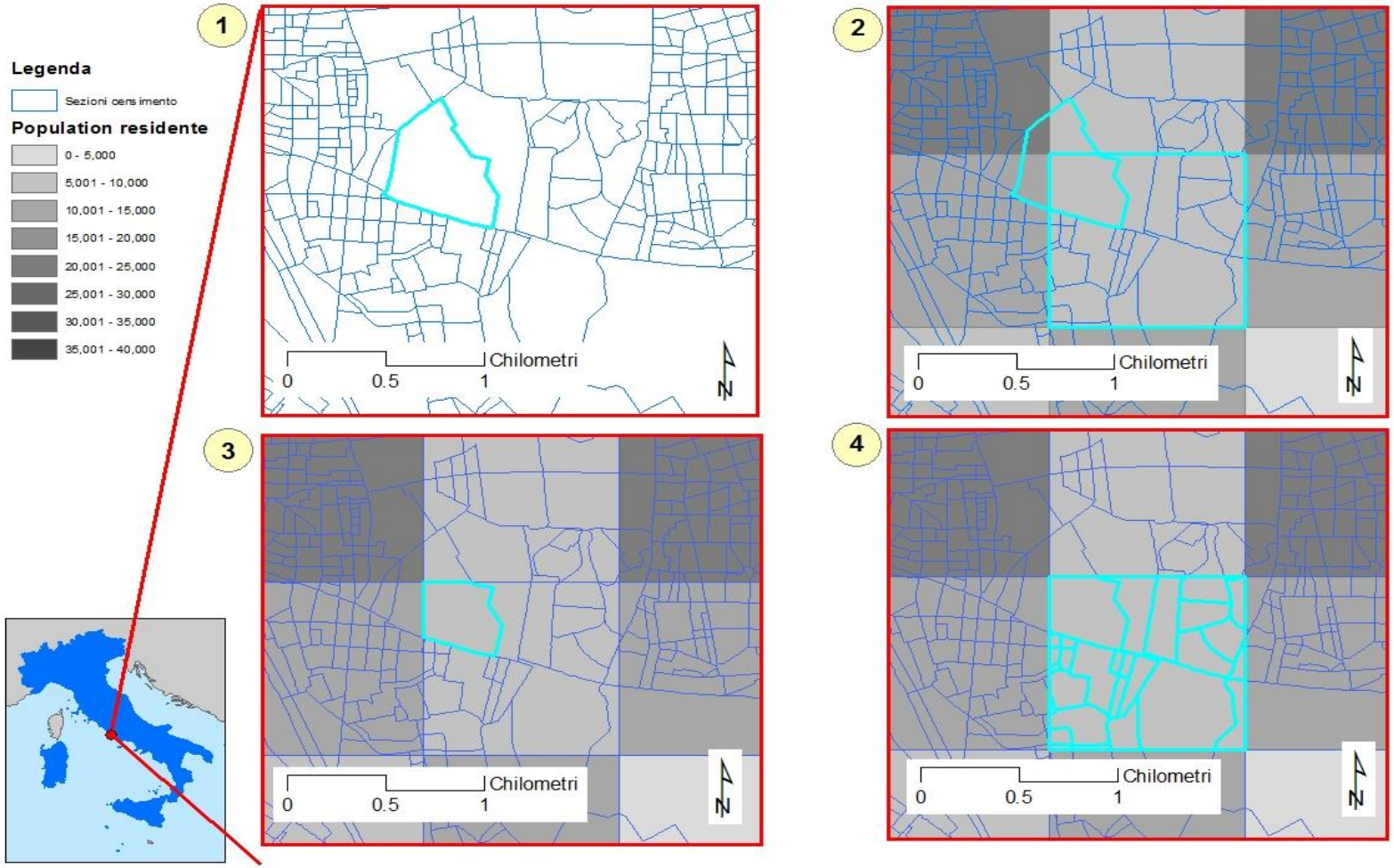
307,635 celle

INDICATORI SPAZIALI. Per ogni cella:

- Ambiti amministrativi (Regione, Provincia, Comune)
- Zone climatiche (arco alpino, pianura padana, alto adriatico, appennino, alto tirreno, medio tirreno, basso adriatico e ionio, basso tirreno e Sicilia, Sardegna)
- Popolazione residente (censimento 2011 della popolazione)
- Variabili topologiche di uso del territorio («Corine Land Cover» 2012)
- Corpi idrici (TeleAtlas TomTom)
- Densità di superficie impervia (Indicatore «ISA» del NOAA)
- Orografia (Modello Digitale di Altitudine)
- Densità stradale (Metri di strade entro cella, per tipologia stradale, TeleAtlas TomTom)
- Emissioni da sorgenti puntuali (743 impianti, dati ISPRA)
- Emissioni da sorgenti areali (stime a livello provinciale, dati ISPRA)

INDICATORI SPAZIALI. Esempi:

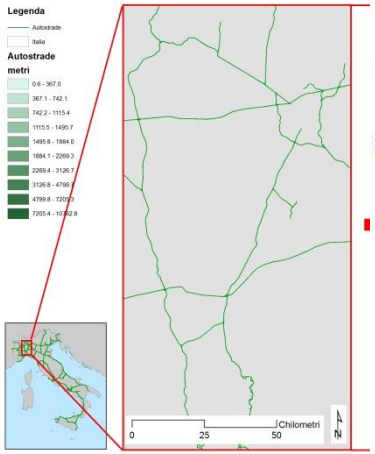
Popolazione residente



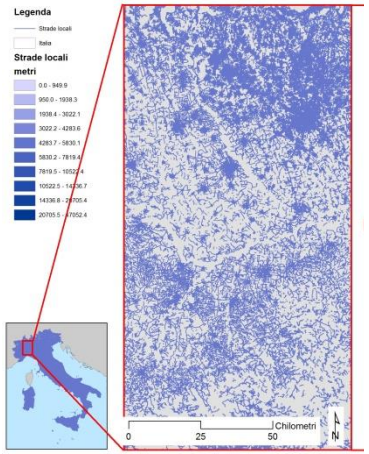
INDICATORI SPAZIALI. Esempi:

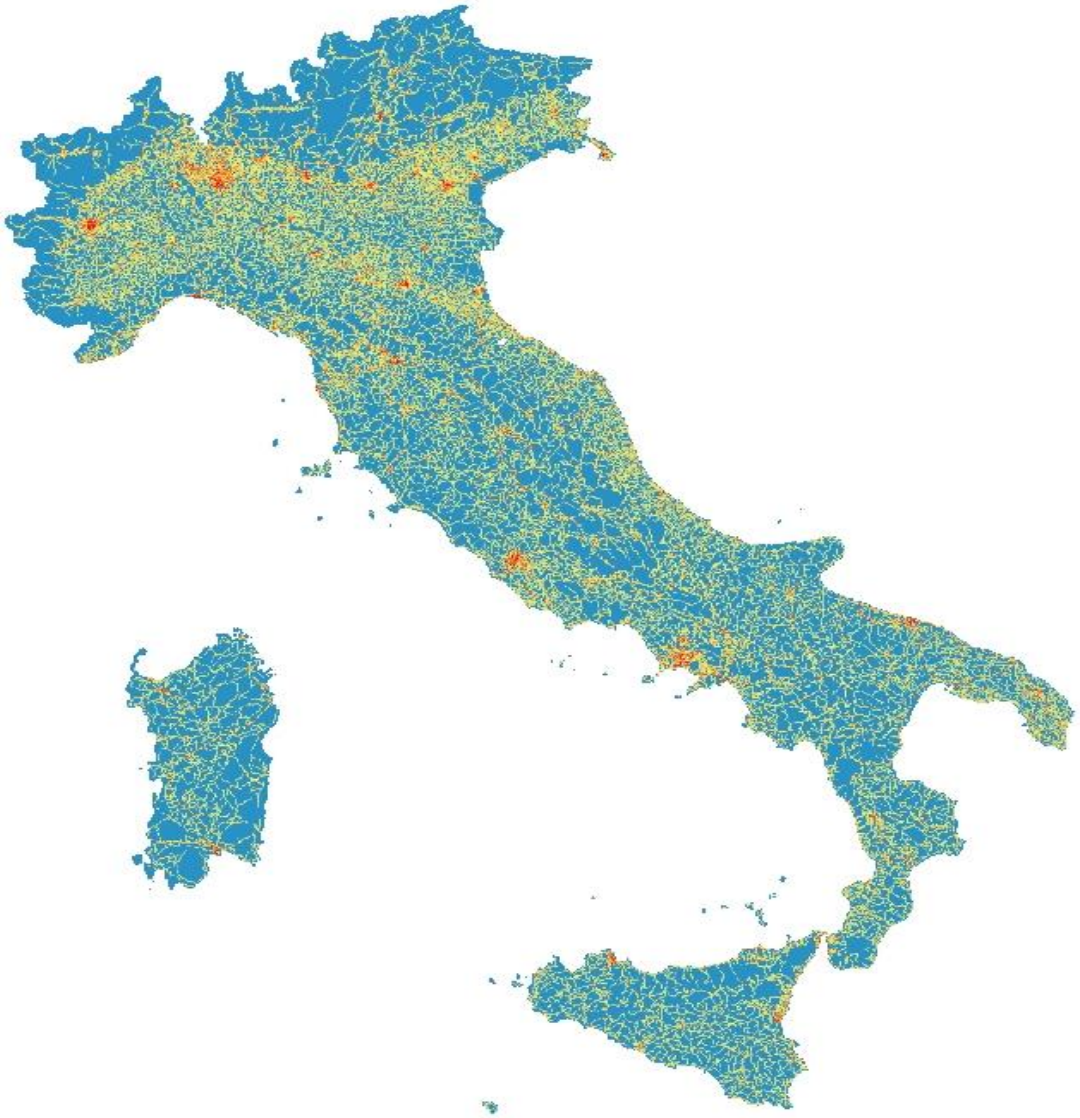
Densità stradale: metri di strade entro cella

Autostrade



Strade locali



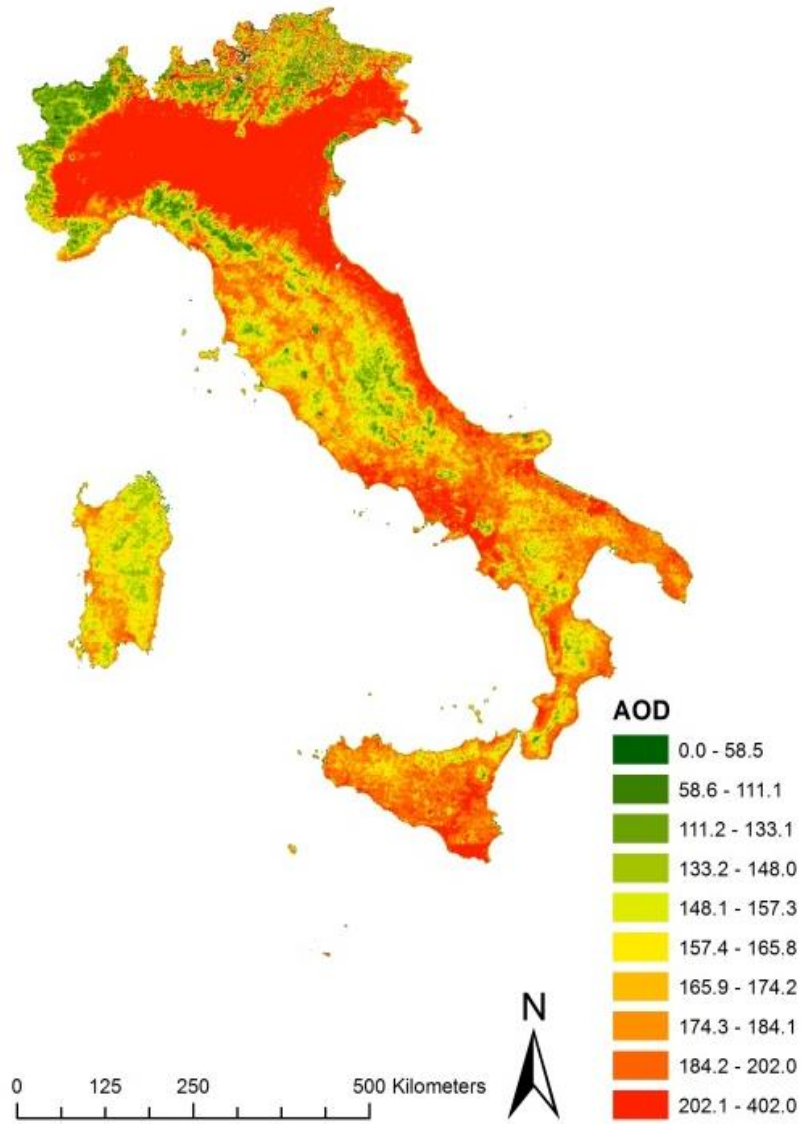


INDICATORI SPAZIOTEMPORALI.
Per ogni cella e giorno:

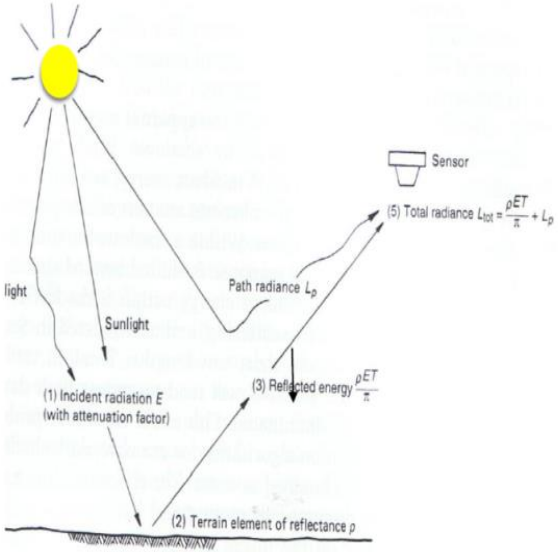
- Dati giornalieri di PM_{10} e $PM_{2.5}$ (stazioni ARPA, dati forniti da ISPRA)
- Dati meteorologici (stazioni ARPA, stazioni WeatherUnderground, dati NOAA)
- Fenomeni di avvezione desertica (modelli atmosferici, retro-traiettorie, dati satellitari)
- «Aerosol Optical Depth» (dati giornalieri AOD forniti da NASA, 1 km^2)
- «Normalized Difference Vegetation Index» (dati mensili NDVI NASA, 1 km^2)
- Altezza dello Strato Limite Planetario (dati orari PBL stimati da ECMWF, ore 0.00 e 12.00, risoluzione spaziale ~ 10*10 km)
- Dati stimati di PM_{10} e $PM_{2.5}$ da modello spaziotemporale, risoluzione spaziale 1-km^2, risoluzione temporale giornaliera, Italia 2006-2015

INDICATORI SPAZIOTEMPORALI. Esempi:

Aerosol Optical Depth (AOD)



- Misura di aerosol distribuiti nella colonna d'aria
- Dato originale raccolto dal MODIS, un sensore a bordo dei satelliti NASA "Terra" e "Aqua", con risoluzione spaziale 10x10-km
- Dati 10x10 rielaborati secondo algoritmo MAIAC, con downscaling a 1-km^2 di risoluzione



Aerosol Optical Depth (AOD) or Aerosol Optical Thickness (AOT) expresses the quantity of light removed from a beam by scattering or absorption during its path through a medium.

Aerosol Optical Depth (AOD)

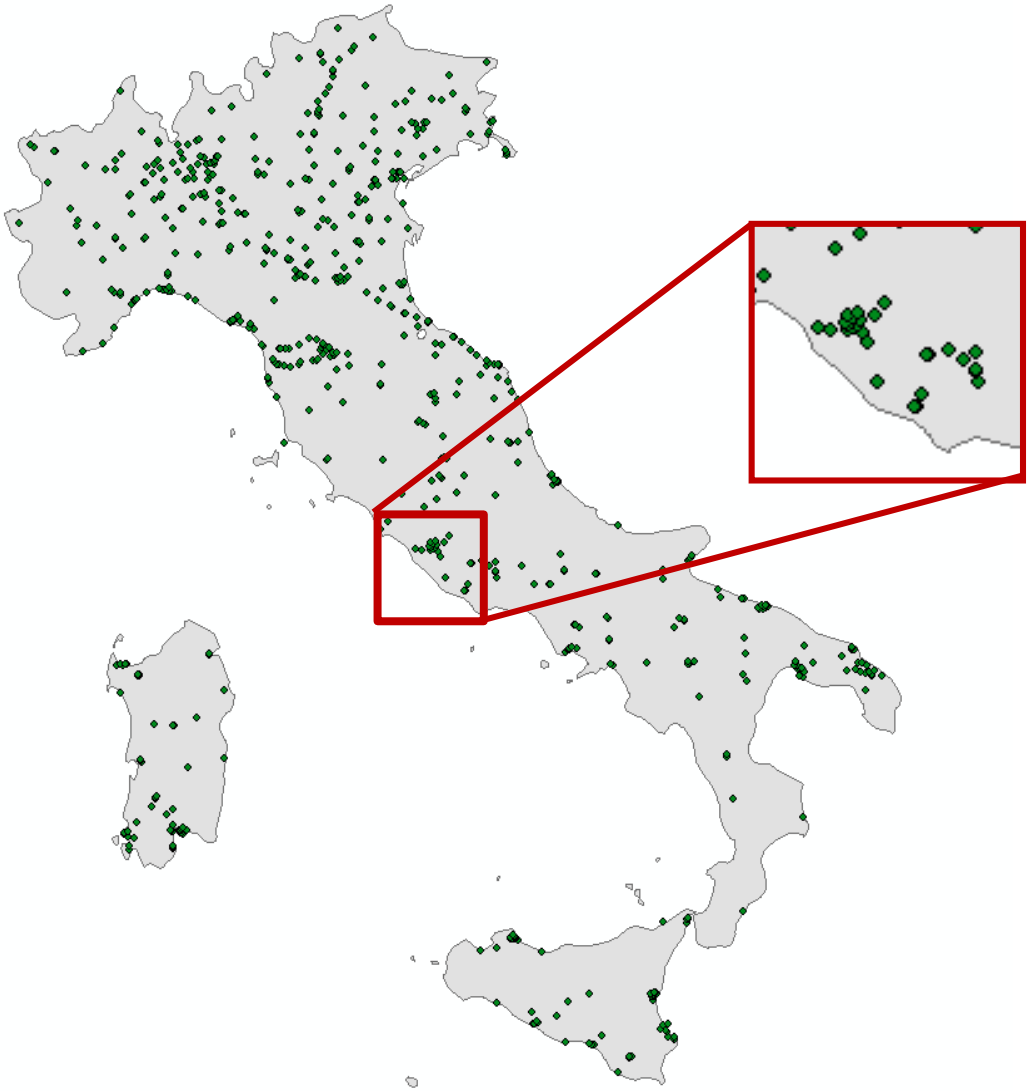
$$\tau_\lambda = \int_{L_2}^{L_1} \beta_\lambda dL$$

INDICATORI SPAZIOTEMPORALI. Esempi:

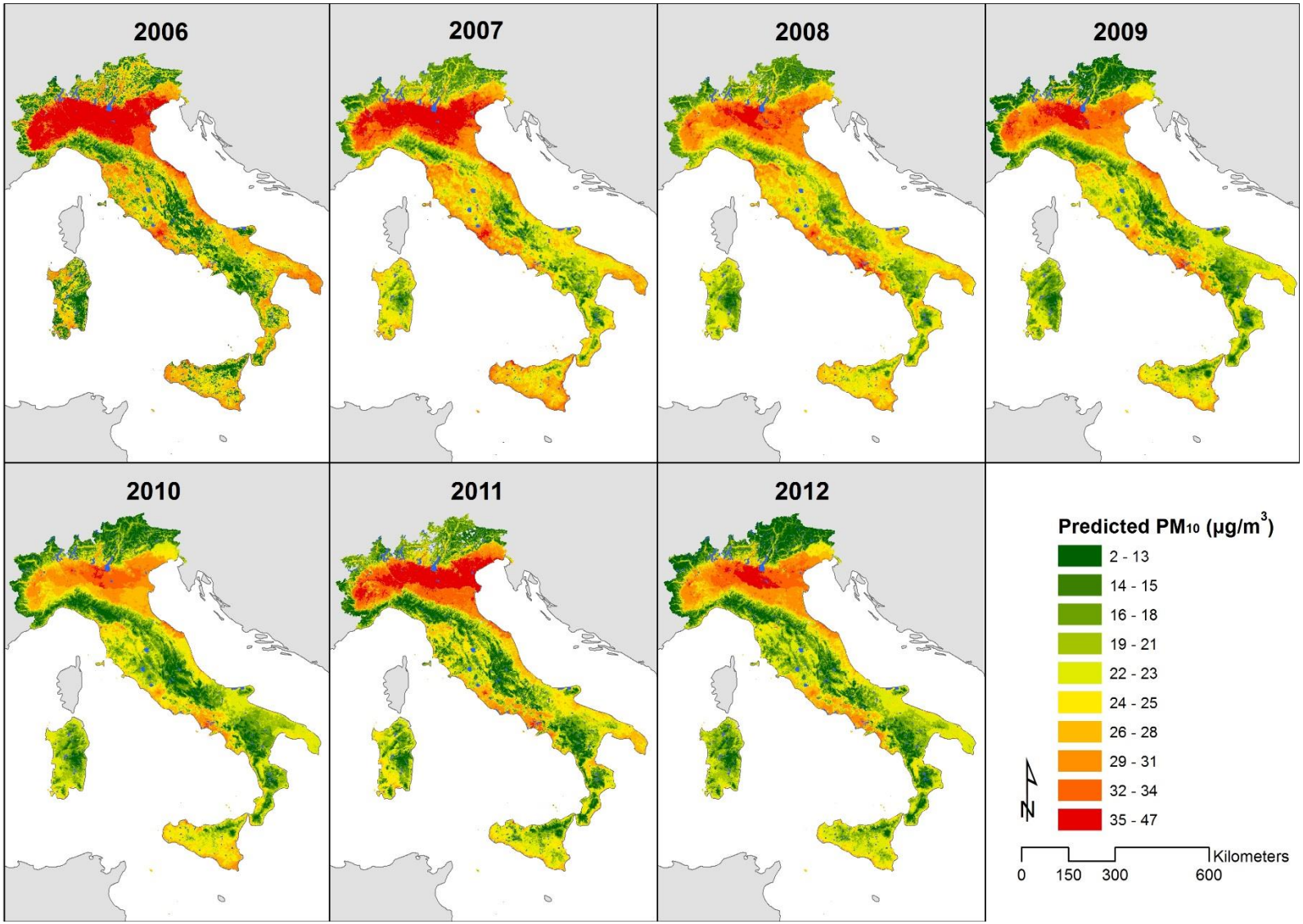
Dati di monitoraggio del PM

686 stazioni

PM_{10} e $PM_{2.5}$

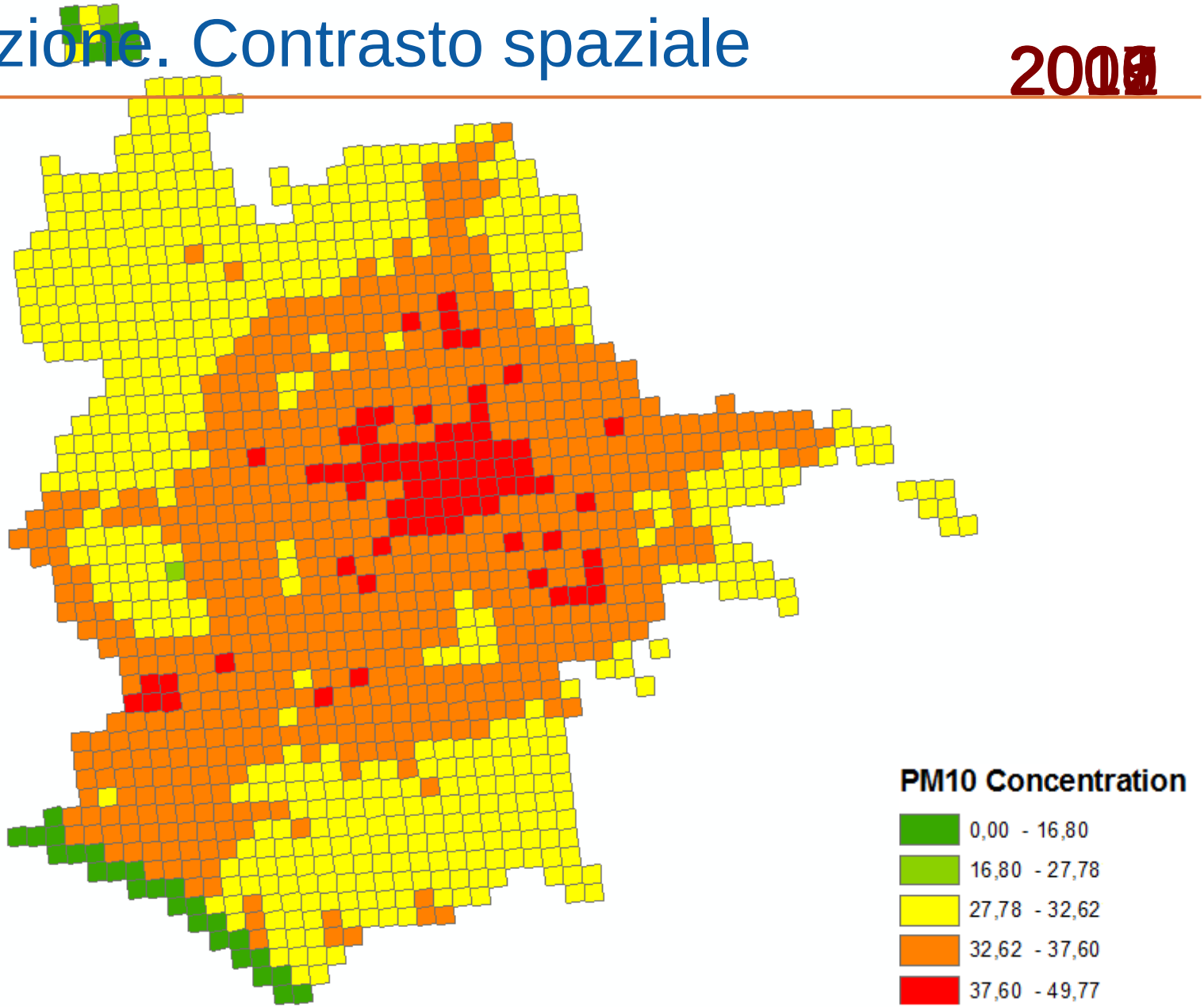


RISULTATI. Trend annuali

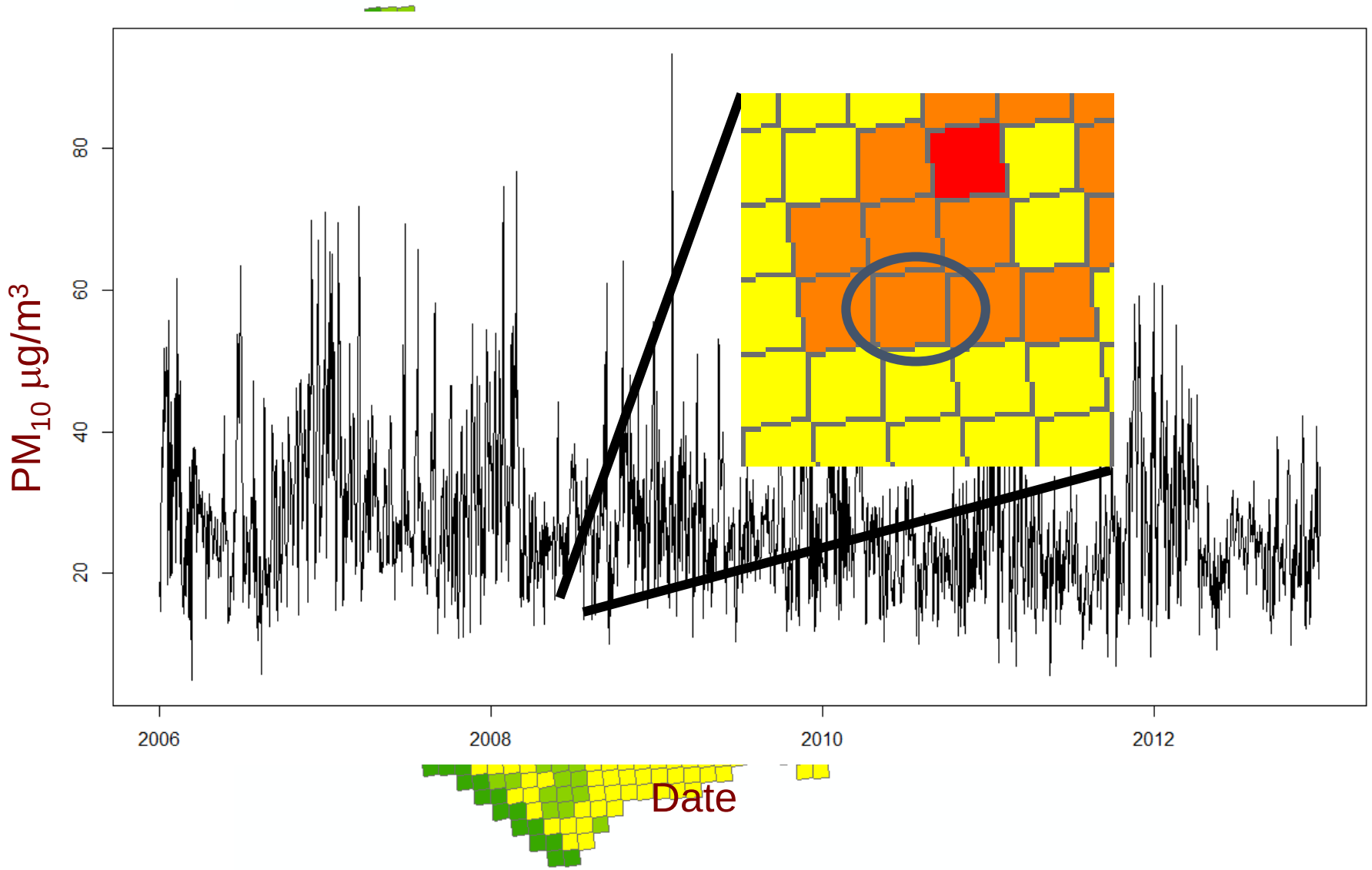


Esposizione. Contrasto spaziale

2001



Esposizione. Contrasto temporale



PROSPETTIVE

- Database nazionali da condividere

- Stime giornaliere di PM_{10}, $PM_{2.5}$ e temperatura dell'aria ad elevata risoluzione spaziotemporale
- Stimolo alla conduzione di studi di epidemiologia ambientale su scala nazionale o locale, con dati e metodologie condivise
- Come condividere in un database nazionale dati di mortalità, ricoveri ospedalieri, prescrizioni farmaceutiche, pronto soccorso?
- Unità elementare: comune……. Sezione di censimento….

Accessibilità dati sanitari

Civitavecchia: Monitoraggio Biologico

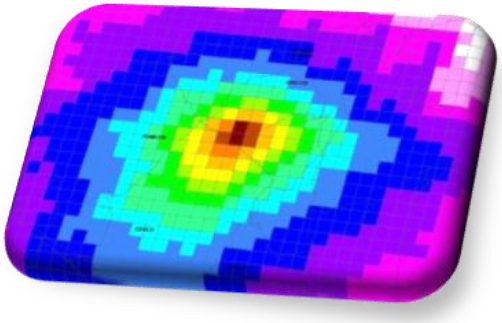
Obiettivo

Confrontare due metodi per la valutazione dell’esposizione individuale:

Modelli di dispersione

vs

Biomonitoraggio umano



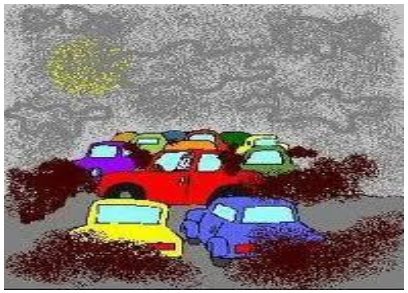
Metodi: Indicatori di esposizione

PM_{10}

Centrale a carbone

NO_x

Traffico (cars+trucks)



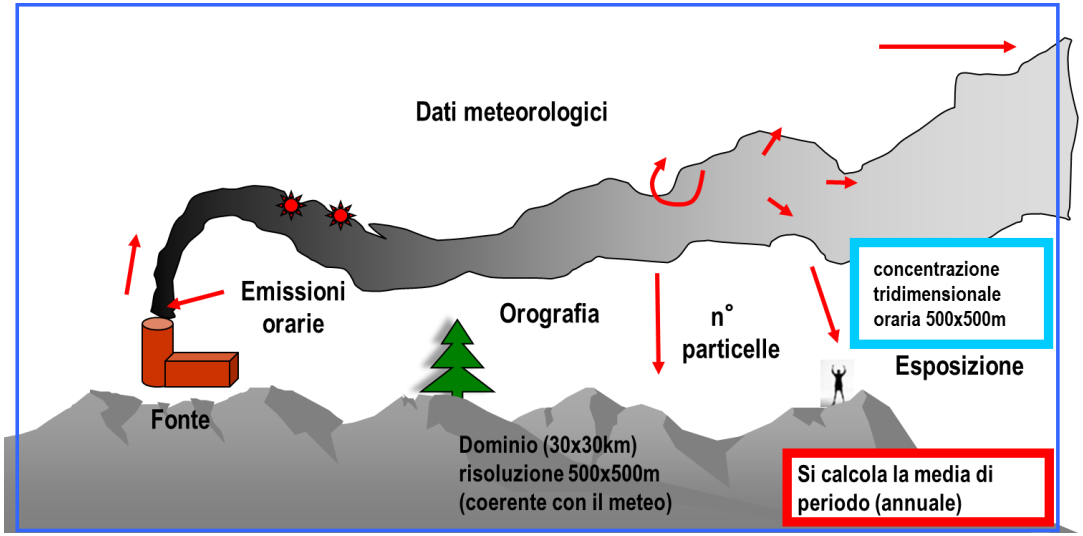
PM_{10}

Porto

PM_{10}

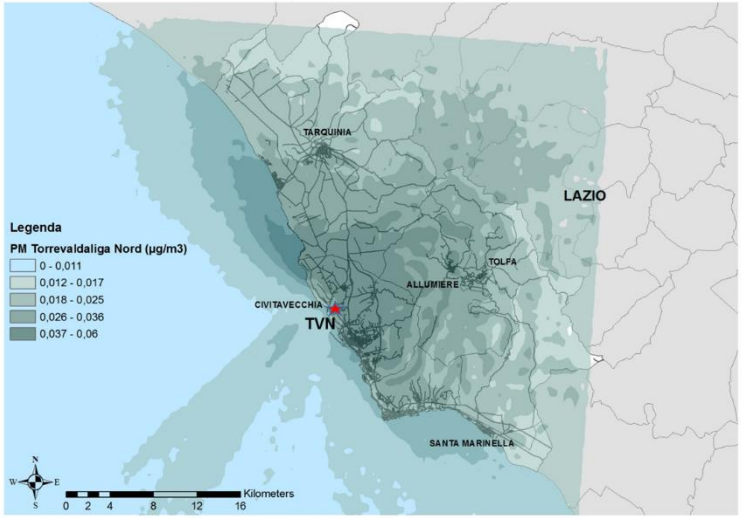
Camini

Modello Lagrangiano SPRAY

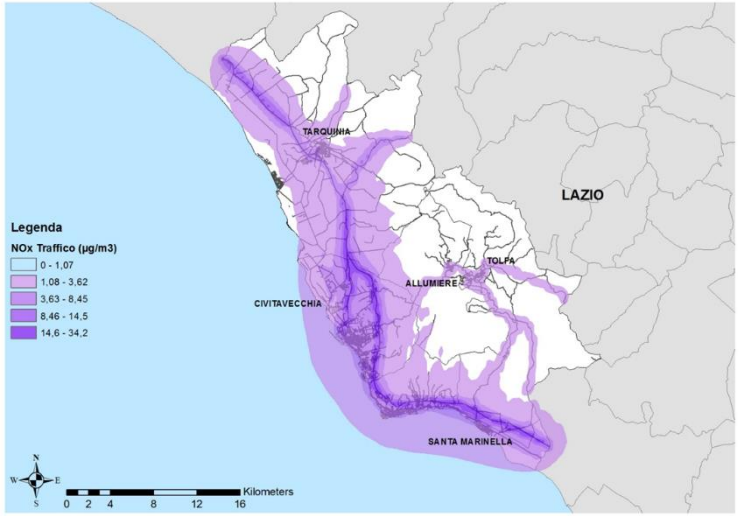


Risultati: modelli di dispersione

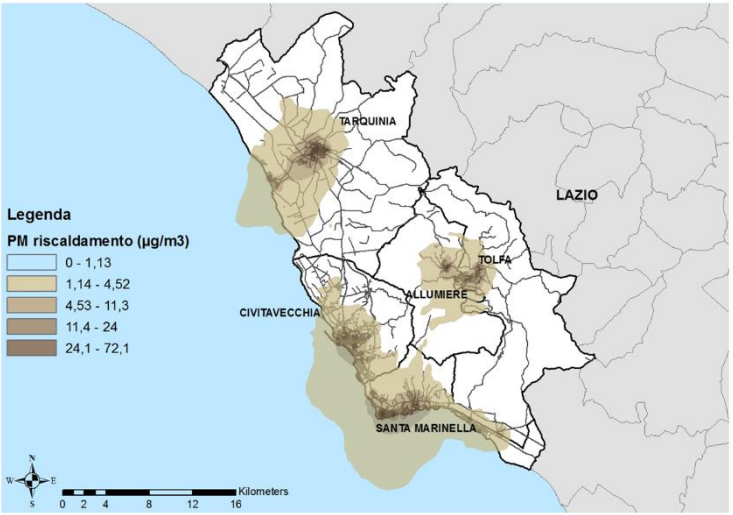
Modello di dispersione degli inquinanti – Centrale Torrevaldaliga Nord – PM_{10} $\mu g/m^3$



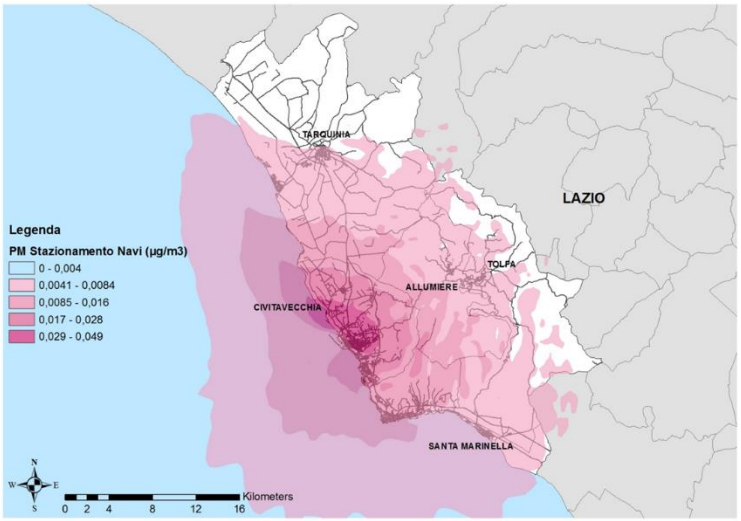
Modello di dispersione degli inquinanti – Traffico stradale – NOx $\mu g/m^3$



Modello di dispersione degli inquinanti – Camini – PM_{10} $\mu g/m^3$



Modello di dispersione degli inquinanti – Porto: stazionamento navi – PM_{10} $\mu g/m^3$



Metodi: Biomarcatori

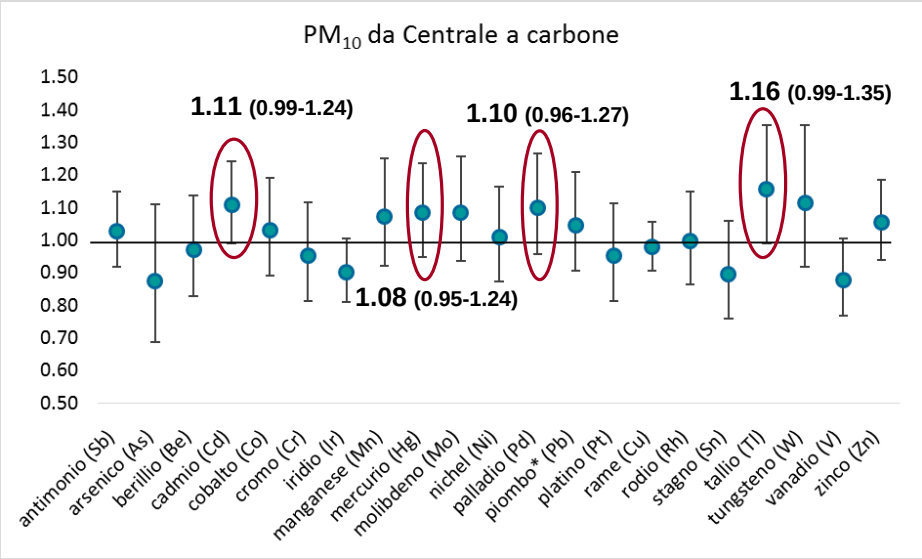
Biomarcatore	NHANES* - USA	Revisione letteratura
Antimonio (Sb)	centrale a carbone	dieta; acqua
Arsenico (As)		centrale a carbone; porto; dieta; acqua
Berillio (Be)	combustione olio e carbone; fumo	fumo; dieta; acqua; rifiuti pericolosi
Cadmio (Cd)	combustione carbone e petrolio; fumo	centrale a carbone; porto; fumo
Cobalto (Co)	combustione carbone e petrolio; traffico	dieta (integratori)
Cromo (Cr)		centrali a carbone; porto; traffico; industria galvanica; fumo; dieta
Iridio (Ir)		traffico
Manganese (Mn)		porto; combustione; dieta
Mercurio (Hg)	combustione carbone; dieta	centrale a carbone; dieta
Molibdeno (Mo)		centrale a carbone; acqua; dieta
Nichel (Ni)		combustione carbone; porto; traffico; combustione; fumo; dieta; bigiotteria; detergenti
Palladio (Pd)	traffico	traffico
Piombo (Pb)	centrale a carbone	porto; dieta; acqua; bottiglie in pet ad alte temperature
Platino (Pt)		traffico
Rame (Cu)		centrale a carbone; porto; traffico
Rodio (Rh)		Traffico
Stagno (Sn)		combustione carbone e petrolio; consumo di prodotti in scatola
Tallio (Tl)	combustione del carbone	combustione carbone
Tungsteno (W)		combustione; cementificio; acqua
Vanadio (V)		porto; carburanti di origine fossile; dieta
Zinco (Zn)		combustione; traffico; dieta

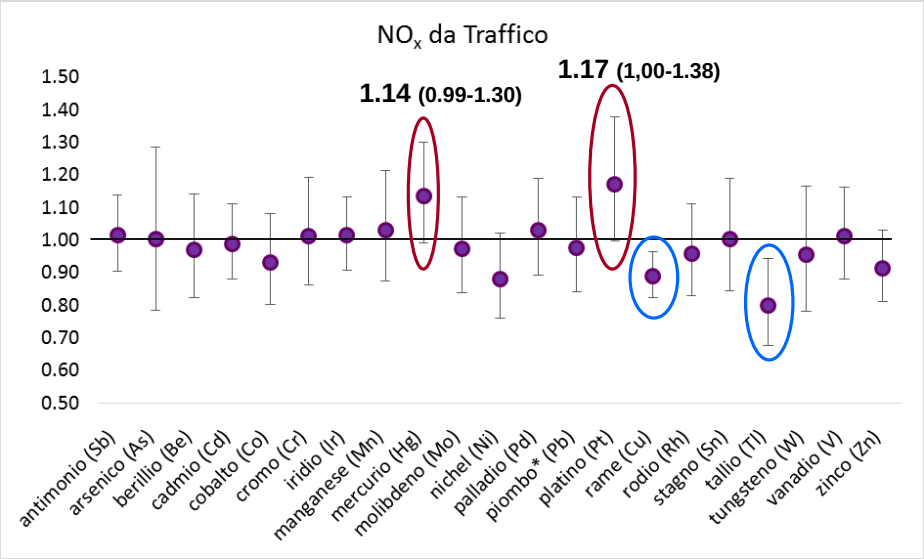
Biomarcatore	Metabolita	Tracciante secondo letteratura
Acido S-fenilmercapturico (SPMA)	Benzene	fumo; traffico; inquinamento industriale
Cotinina	Nicotina	fumo

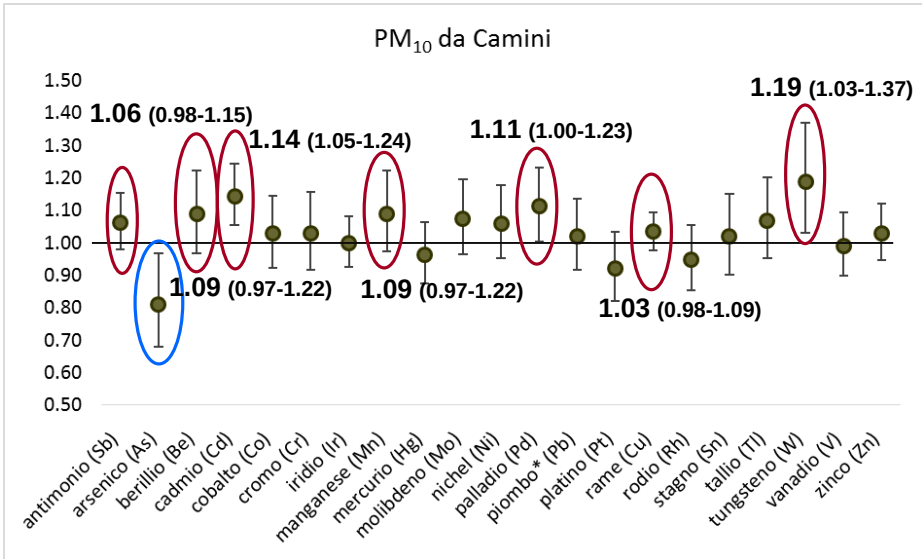
Metaboliti degli IPA	Tracciante secondo letteratura
1-OH pirene	traffico
1-OH naftalene	fumo
2-OH naftalene	fumo
1+9-OH fenantrene	traffico, riscaldamento
2-OH fenantrene	traffico, riscaldamento
3-OH fenantrene	traffico, riscaldamento
4-OH fenantrene	traffico, riscaldamento
2-OH fluorene	riscaldamento

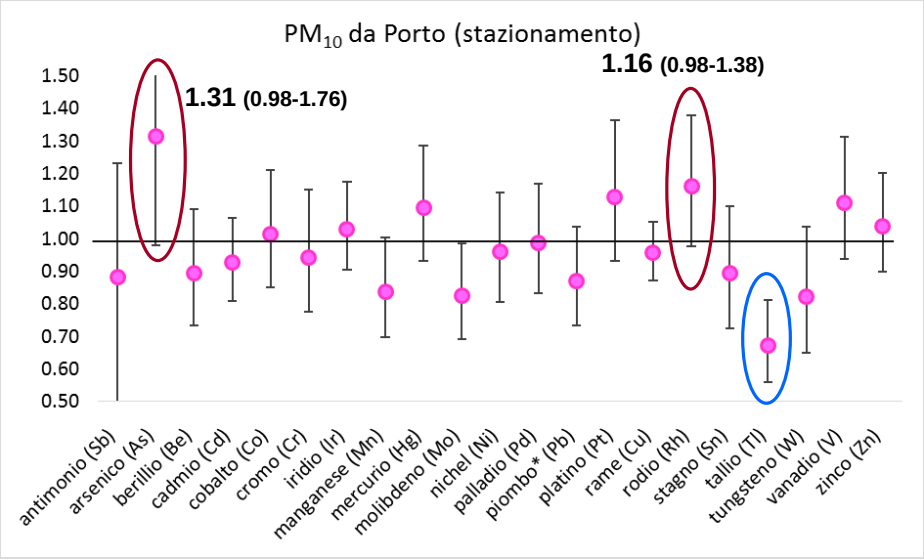
AMBIENTE
BIOMONITORAGGIO
CIVITAVECCHIA

Associazione tra indicatori di esposizione e concentrazione urinaria di metalli pesanti - GMR, 95% I.C.



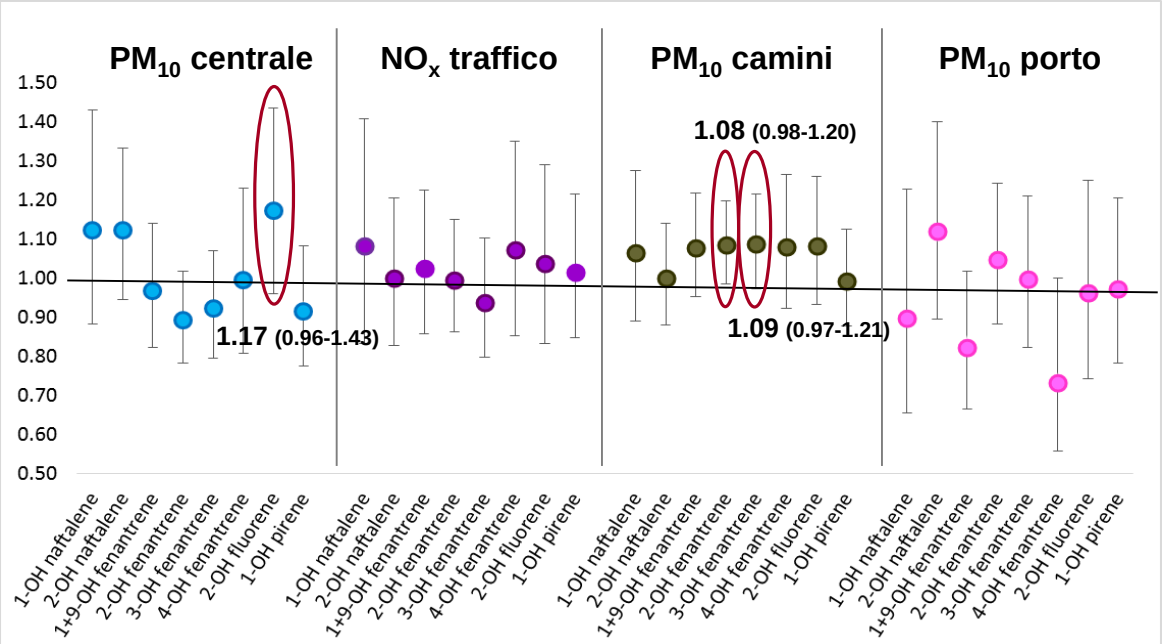


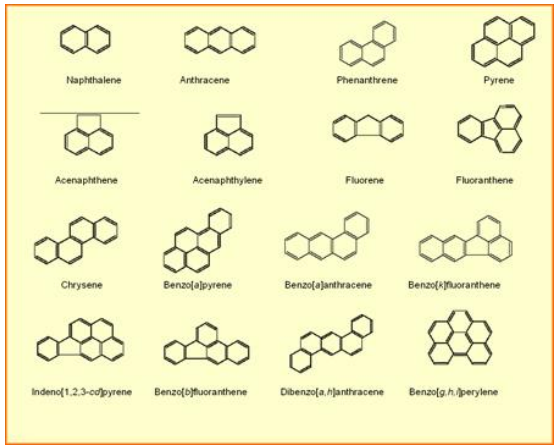




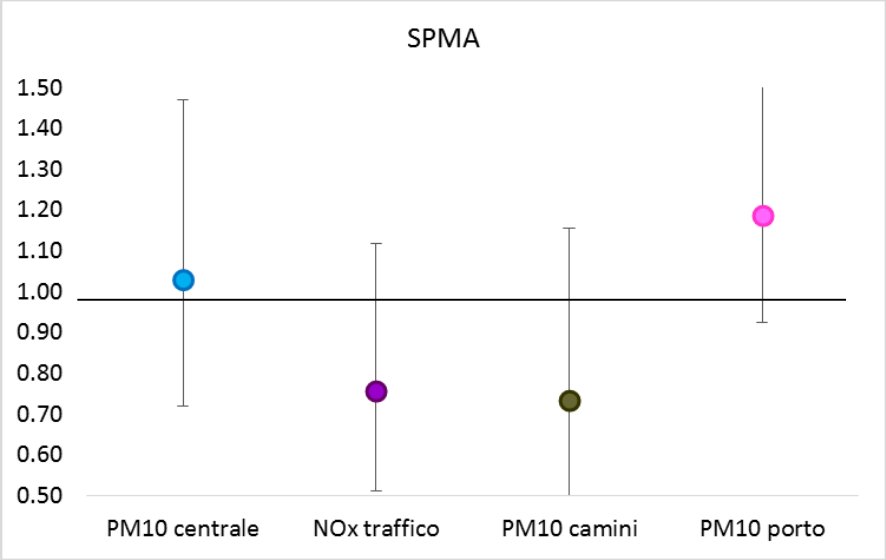
GMR aggiustate per concomitanti esposizioni ambientali, creatinina, periodo di arruolamento, caratteristiche demografiche, fattori di rischio (backward procedure)

Associazione tra indicatori di esposizione e concentrazione urinaria di IPA e benzene - GMR, 95% I.C.





GMR aggiustate per concomitanti esposizioni ambientali, periodo di arruolamento, caratteristiche demografiche, cotinina, fumo, alcol, IMC, occupazione a rischio, tipo di riscaldamento



Associazione tra indicatori di esposizione e concentrazione urinaria di metalli pesanti, IPA e benzene - GMR, 95% I.C.

	Tallio	GMR	[95% Conf.Interval]	
increm concentraz 95°p - 5°p	PM TVN			
increm concentraz 95°p - 5°p	NOx traffico			
increm concentraz 95°p - 5°p	PM porto			
increm concentraz 95°p - 5°p	PM riscaldar			
	femmine			
	45 - 54			
	55 - 64			
	>=65			
laboratorio analisi	secondo blo			
	terzo blocco			
	quarto bloc			
Istruzione	Media infer			
	Media supe			
	Laurea/Titol			
	Lavoratore			
	Casalinga			
	Pensionato/			
	uso camino/			
fumo	si			
	ex			
consumo di alcol	meno di un			
	1-2 unità a s			
	pù di 2 unità			
	1-2 unità al			
	più di 2 unit			
	uso bigiotte			
	consumo pe			

	1-OH pirene	GMR	[95% Conf.Interval]	
increm 95°p - 5°p	PM TVN	0.91	0.77	1.08
increm 95°p - 5°p	NOx traffico	1.01	0.85	1.21
increm 95°p - 5°p	PM camini	0.99	0.88	1.12
increm 95°p - 5°p	PM porto(staz.)	0.97	0.78	1.21
increm 1000 ng/ml	cotinina	1.11	1.08	1.13
genere	femmine	1.22	1.06	1.41
eta	45 - 54	0.96	0.83	1.11
	55 - 64	1.04	0.89	1.23
	>=65	0.99	0.80	1.24
istruzione	Media inferiore	1.22	0.98	1.51
	Media superiore	1.12	0.91	1.38
	Laurea/Titolo superiore	1.17	0.89	1.54
Stato occupazionale	Lavoratore	1.00	0.78	1.28
	Casalinga	1.04	0.80	1.36
	Pensionato/Invalido	0.96	0.72	1.27
occupazione a rischio	occupazione a rischio	1.23	1.08	1.41
ALCOL	meno di un unità a settimana	0.89	0.76	1.05
	1-2 unità a settimana	0.91	0.78	1.06
	pù di 2 unità a settimana	1.02	0.83	1.26
	1-2 unità al giorno	0.99	0.85	1.16
	più di 2 unità al giorno	1.24	0.92	1.67
BMI	<18.5	0.94	0.52	1.70
	25-29.99	0.93	0.82	1.06
	30-34.99	0.80	0.68	0.94
	>34	0.88	0.70	1.11
	camino/stufa	1.01	0.90	1.14
stagione	estate	0.75	0.63	0.90
	autunno	0.62	0.54	0.73
	inverno	0.71	0.60	0.84

	Cadmio	GMR	[95% Conf.Interval]	
		1.12	1.00	1.25
		0.99	0.88	1.11
		0.94	0.82	1.08
		1.14	1.05	1.23
		1.43	1.32	1.55
		1.13	1.03	1.24
		1.24	1.12	1.37
		1.41	1.25	1.59
		0.73	0.64	0.84
		0.74	0.66	0.82
		0.72	0.65	0.81
		0.85	0.73	0.99
		0.75	0.66	0.86
		0.95	0.85	1.07
		0.88	0.74	1.06
		1.10	0.99	1.23
		1.32	1.21	1.44
		1.04	0.96	1.13
		0.95	0.86	1.05
		0.92	0.83	1.02
		0.89	0.78	1.01
		0.86	0.77	0.95
		0.86	0.71	1.05
		1.59	1.06	2.37
		1.04	0.96	1.13
		0.98	0.88	1.09
		0.96	0.83	1.11

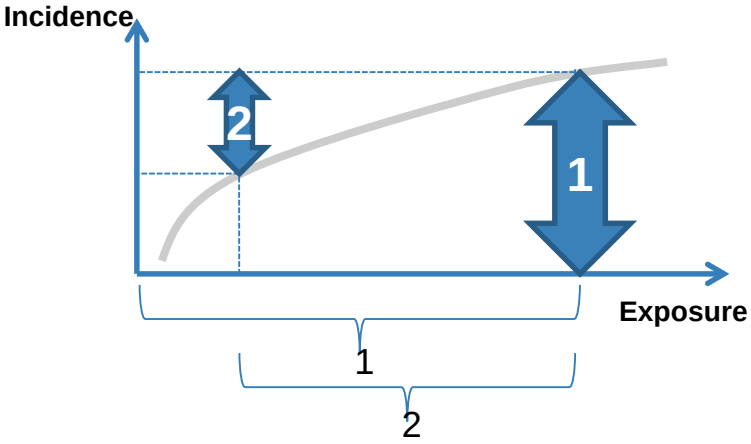
Health Impact Assessment (HIA)

A combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population

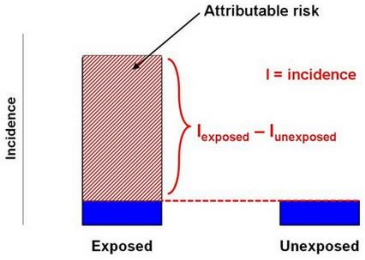
WHO, European Centre for Health Policy. Gothenburg Consensus Paper, Health Impact Assessment- main concepts and suggested approach. Brussels, 1999.

Two key questions of Health Impact Asssessment

1. What is the health burden of a given exposure level?
2. What is (would be) the impact of the exposure change?



Attributable risk



Population Attributable Risk (PAR): difference between the incidence of a disease in population with "real world" exposure and (often hypothetical) population not exposed; incidence attributable to the exposure.

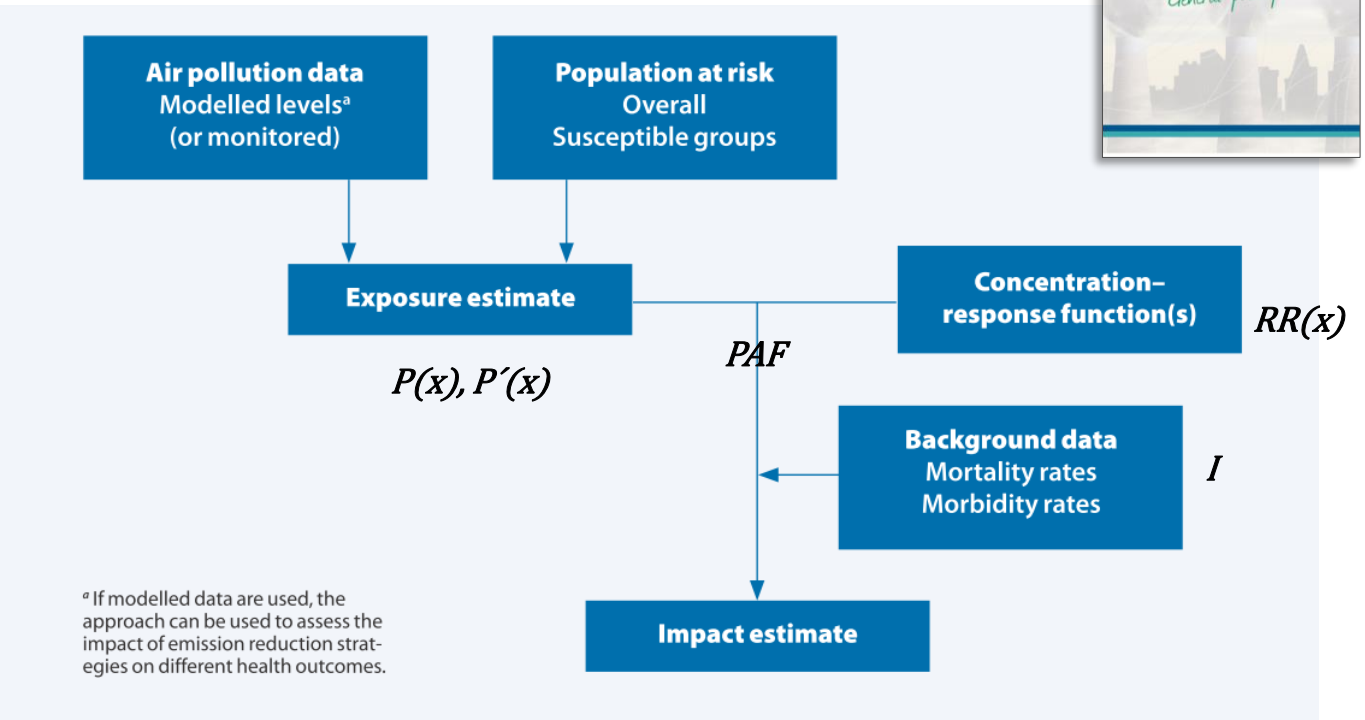
$$PAR = I_{exposed} - I_{not\ exposed}$$

Population Attributable Fraction (PAF): fraction of the cases attributable to the exposure

$$PAF = (I_{exposed} - I_{not\ exposed}) / I_{exposed} = \frac{RR-1}{RR}$$

$$PAR = PAF * I_{exposed}$$

Main steps in health risk assessment of air pollution



http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2016/health-risk-assessment-of-air-pollution.-general-principles-2016

High priority list of environmental stressors	Medium priority list of environmental stressors:
Benzene Dioxins (including furans and dioxin like PCBs) Second-hand smoke (SHS) Formaldehyde Lead Transport noise Ozone Particulate matter Radon	1,2-Dichloroethane Accidents - domestic Accidents - traffic Acrylamide Arsenic Chlorination by-products Carbon monoxide (CO) Damp housing Foodborn epidemics Indoor insecticides Methyl mercury UV radiation Waterborne epidemics

DALY = YLL + YLD

where:
YLL = Years of Life Lost due to premature mortality.
YLD = Years Lost due to Disability.

Years of Life Lost (YLL) in a case of individual death is calculated as the difference between the standard life expectancy at the age of death and the actual age at death. When population data is tabulated for age

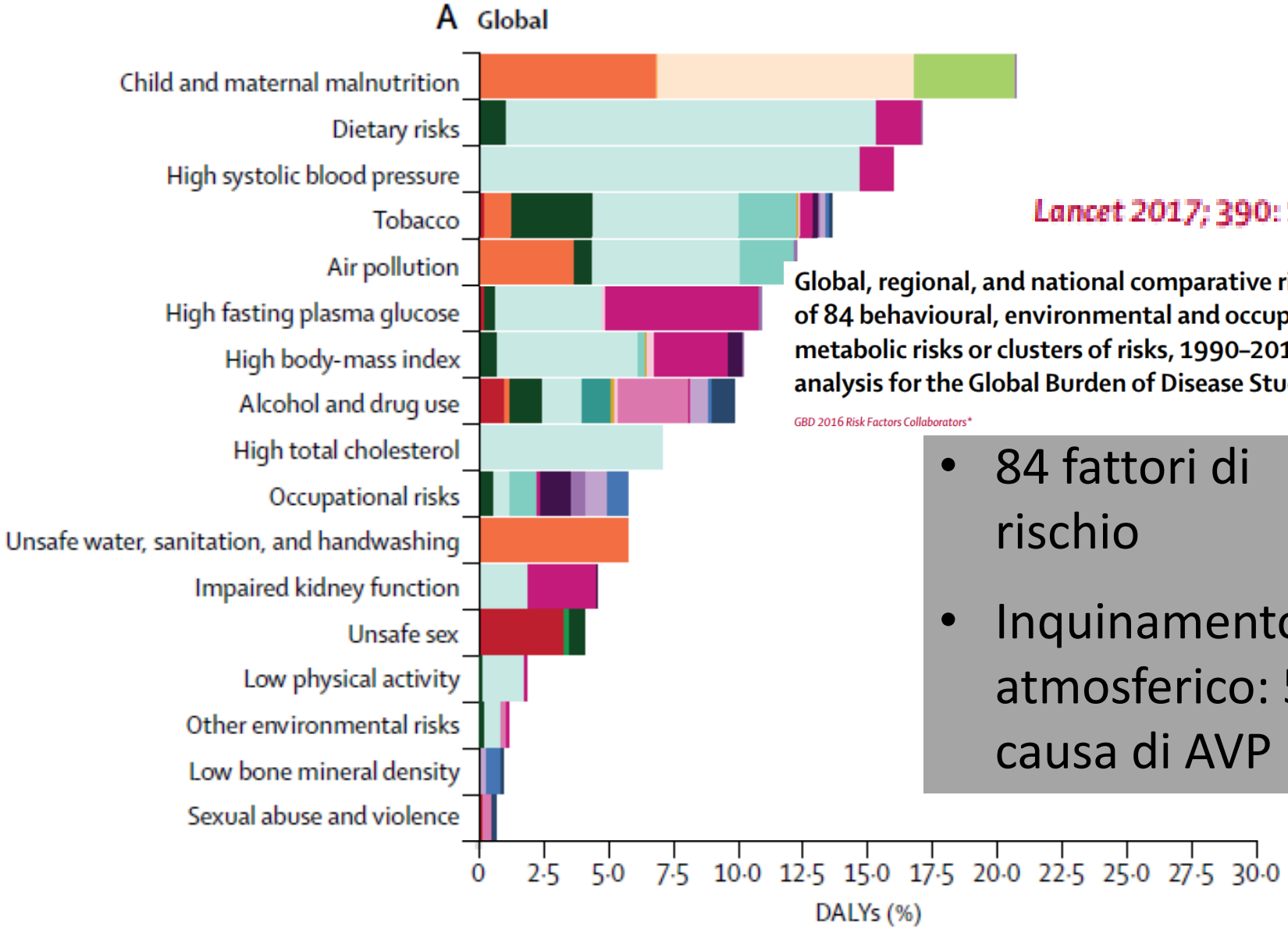
To estimate the Years Lost due to Disability (YLD), the number of disability cases is multiplied by the average duration of the disease and a disability weight (see further discussion below). The basic formula is:

YLD = n x DW x L

where:
YLD = Years Lost due to Disability
n = number of incident cases.
DW = disability weight.
L = average duration of disability (years)

Contributo relativo dei 9 fattori ambientali sull'impatto sanitario in Italia per l'anno.
Anni di vita persi aggiustati per malattia (DALYs) per milione di abitanti

	DALYs totali		DALYs per milione	
	n.	%	n.	%
PM2.5	545,543	69.3	9,377.6	69.3
Fumo passivo	56,746	7.2	975.4	7.2
Piombo	55,018	7.0	945.7	7.0
Radon	50,378	6.4	866.0	6.4
Rumore da traffico	42,728	5.4	734.5	5.4
Diossine	28,113	3.6	483.2	3.6
Ozono	8,038	1.0	138.2	1.0
Benzene	245	0.0	4.2	0.0
Formaldeide	0	0.0	0.0	0.0
Totale	**786,808**	**100.0**	**13,524.8**	**100.0**

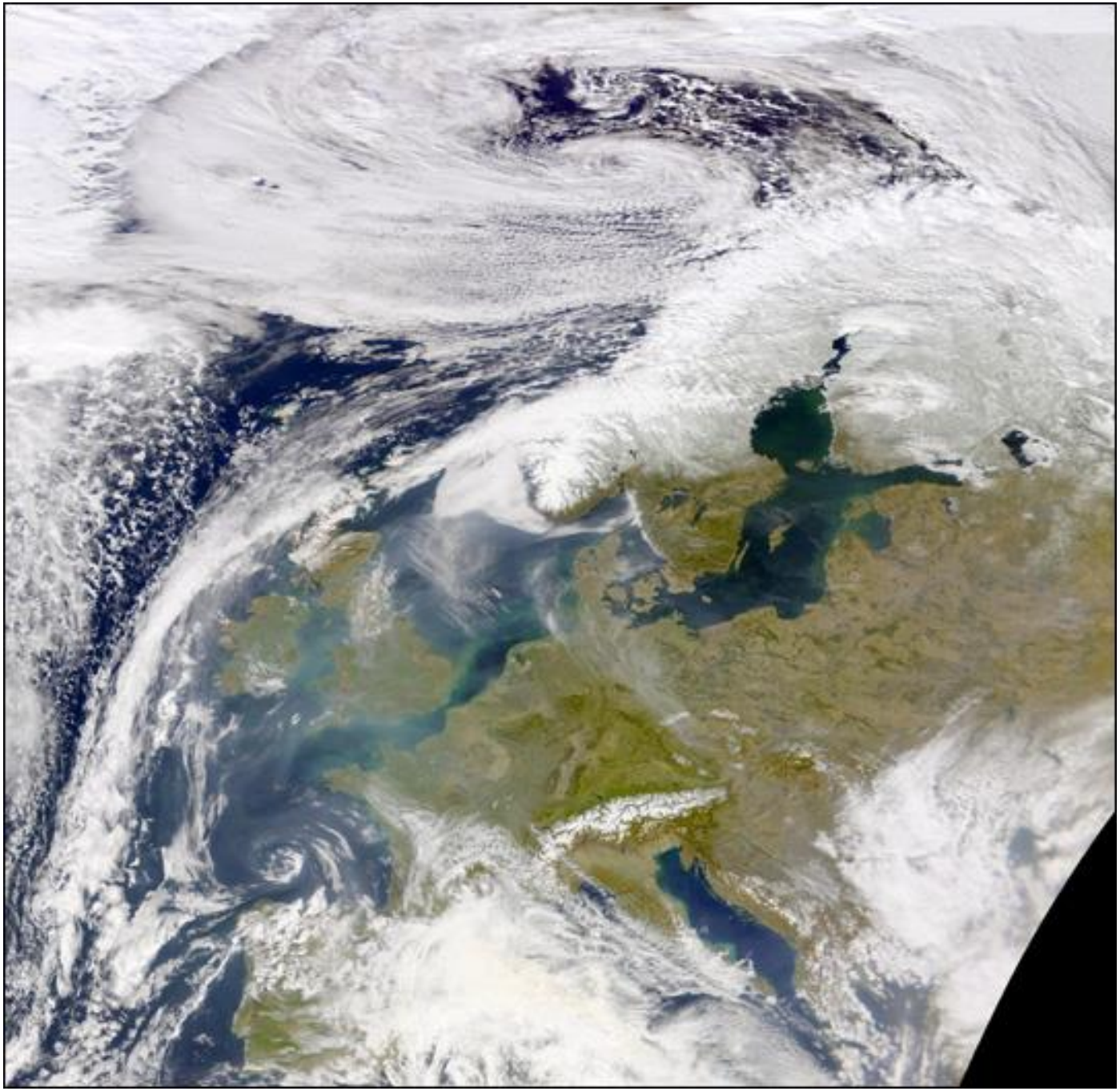


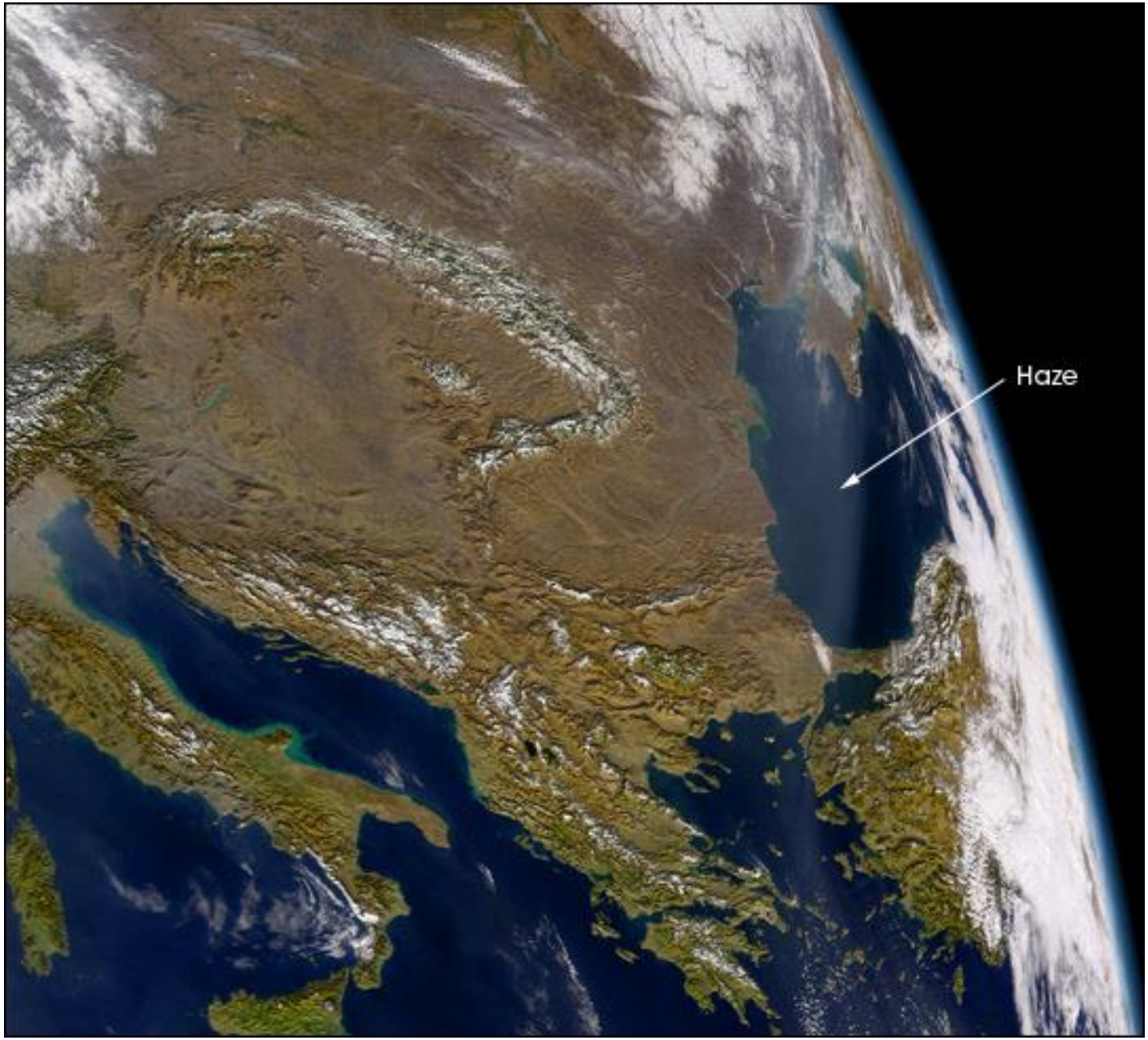
Lancet 2017; 390: 1345–422

Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016

*GBD 2016 Risk Factors Collaborators**

- 84 fattori di rischio
- Inquinamento atmosferico: 5ª causa di AVP

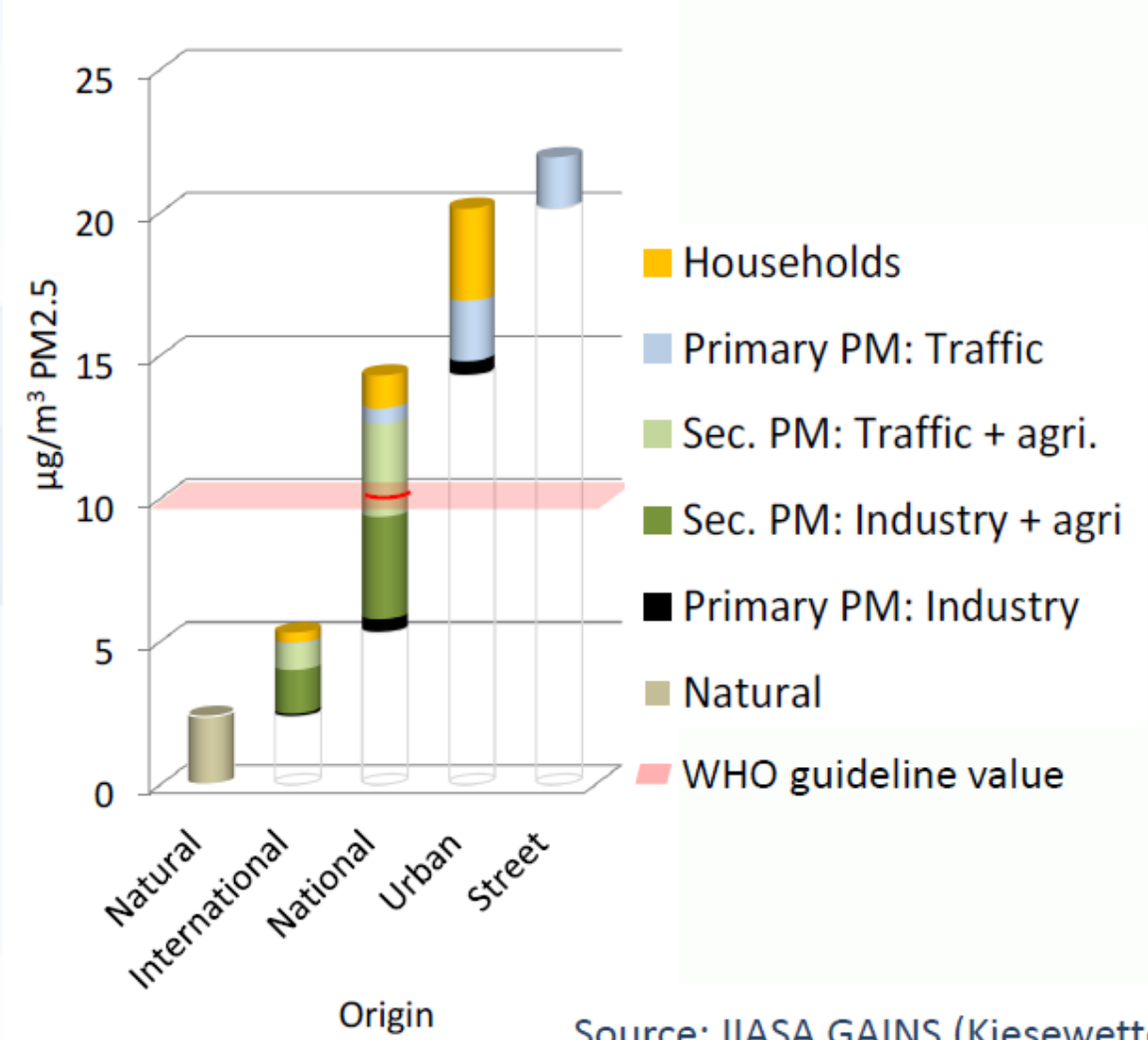



Haze

Origin of PM2.5 in Italy

Average of 70 urban AIRBASE stations modelled in GAINS

2009



Source: IIASA GAINS (Kiesewetter et al., 2014)

Quali condizioni e quali azioni

- fattore di rischio noto, effetti noti
  - sorveglianza ambientale (limiti di legge, esposizione popolazione)
  - Epidemiologia descrittiva
  - HIA
- fattore rischio noto, effetti non noti
  - sorveglianza ambientale (limiti di legge, esposizione popolazione)
  - Epidemiologia analitica
- Condizione/malattia con componente ambientale sospetta
  - Epidemiologia descrittiva
  - Epidemiologia analitica

    con accurata valutazione della esposizione

Response to Environmental Pollution

More Research May Not Be Needed

David A. Savitz

Epidemiology, 2016

One form of applied research can be of great value in such circumstances: **health impact assessment.** If the exposure circumstances can be estimated with reasonable accuracy, ideally with information on the increment in exposure due to the episode relative to baseline levels, then a far better estimate of the health impact would be generated by applying current scientific knowledge of exposure–disease relationships than by conducting a new study in the population of interest. While it could be argued that unique attributes of this population make application of the standard risk estimates questionable, it is very unlikely that a study with sufficient precision can be done in the affected population to demonstrate such effect modification. **In contrast to protracted, expensive, and disappointing etiologic research, credible risk estimates should be attainable within weeks or a few months of the episode. A quick and dirty estimate of health consequences of this nature is likely to have a more favorable cost–benefit balance than a more ambitious, often futile, new epidemiologic study.**

Conclusioni

- Petenzialità e limiti della sorveglianza ambientale ed epidemiologica
- Necessità di database nazionale
- Indicazioni operative a livello regionale per sorveglianza ed HIA
- Integrazioni regionali sistema protezione ambientale e SSN

Grazie