Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

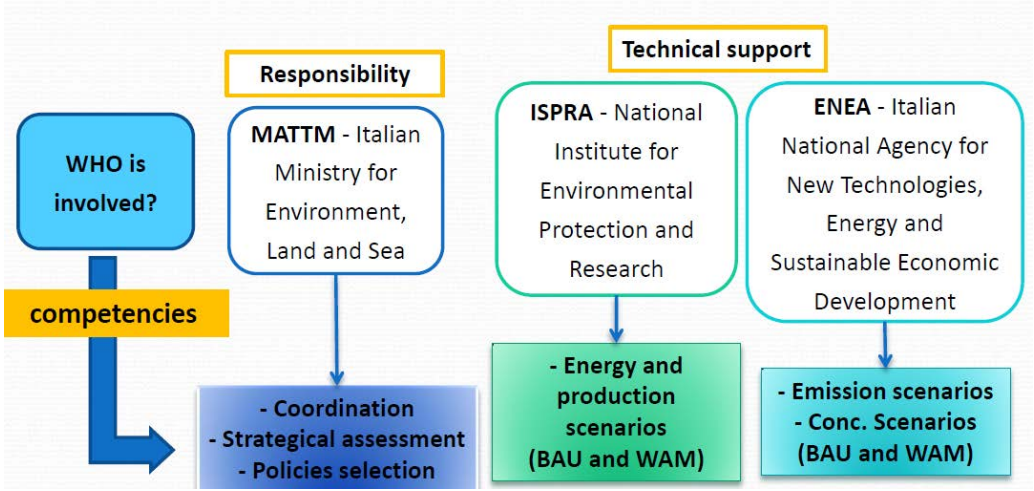
The Italian NAPCP under the NEC Directive: Air Quality, Health Impact and Cost Assessment

TFIAM
21-23 April 2021

Antonio Piersanti, Ilaria D'Elia – Lab. Atmospheric Pollution

The NEC DIRECTIVE in ITALY

- The new National Emission Ceilings (NEC) Directive entered into force in December 2016. Emission reduction commitments for the year 2020 and 2030 with respect to the base year 2005 for SO_2, NO_X, PM2.5, NMVOC and NH_3 implemented in Italy with Decree 81/2018
- Final **National Air Pollution Control Programme (NAPCP)** submitted on 22 September 2020



Annex IV Part 2 of the Directive ('National emission projections') indicates that two emissions projection scenarios are required:

- Member States shall provide a **'with measures' (adopted measures) scenario (WM)**, and;
- Where relevant, a '**with additional measures' (planned measures)** projection for each pollutant **(WAM)**.

BAU = Business As Usual scenario = WM

From Air Quality to Health Impact and related Cost

atmosphere Special issue MDPI

Air Pollution in Europe: Source Apportionment, Trends and Emission-Reduction Measures

Guest Editor:

Dr. Marta García Vivanco

Article

The Italian National Air Pollution Control Programme: Air Quality, Health Impact and Cost Assessment

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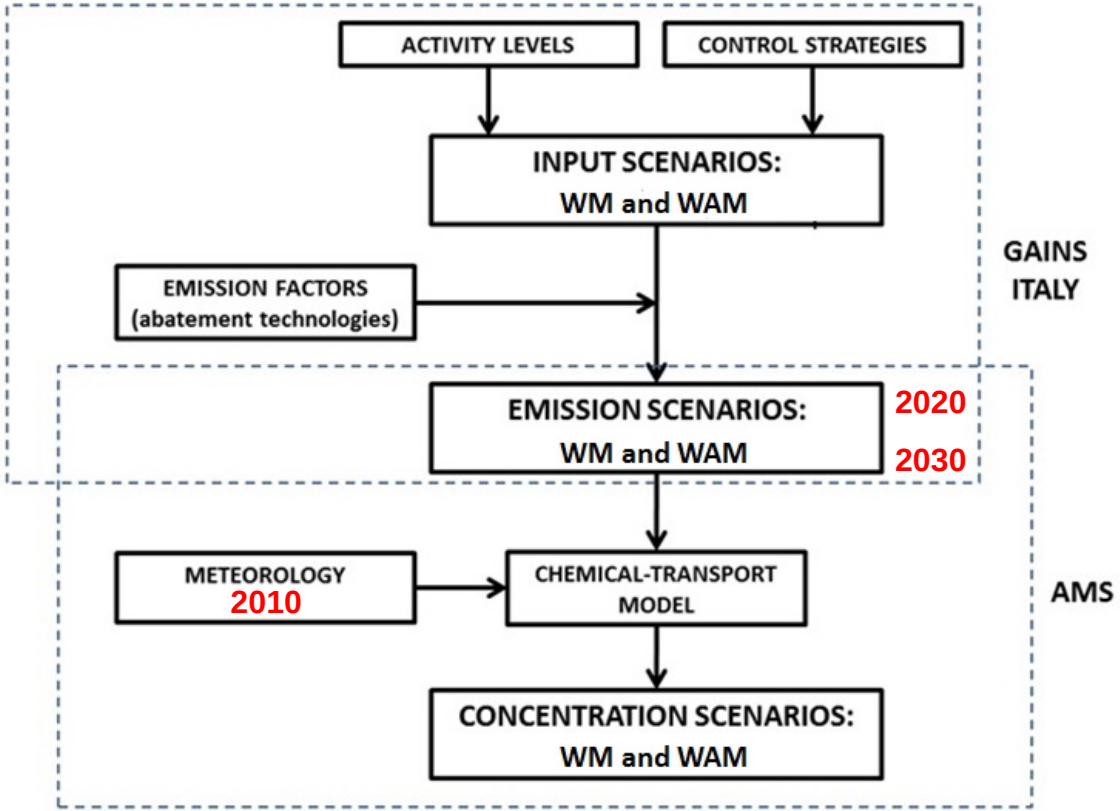
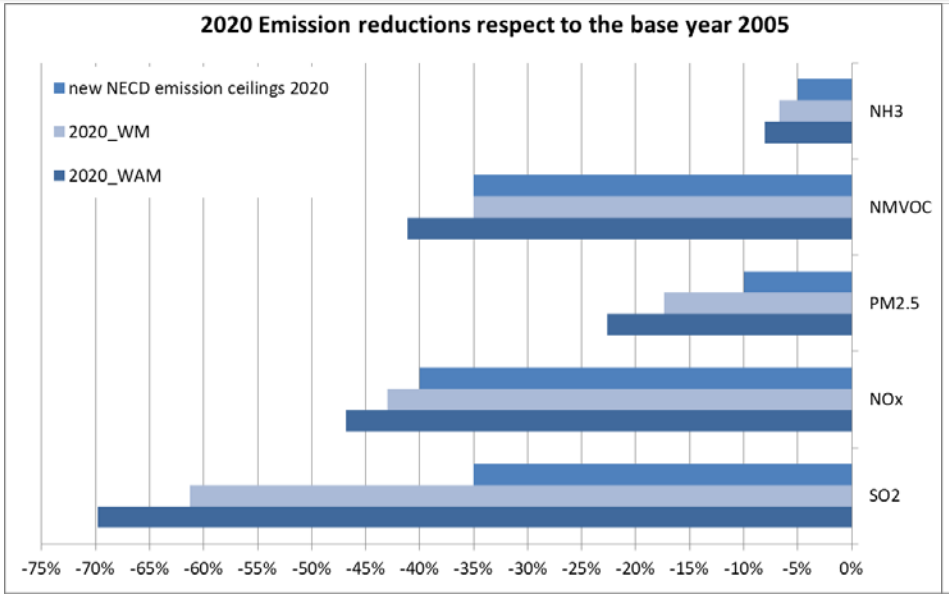
Atmosphere, 2021, 12, 196. doi: 10.3390/atmos12020196

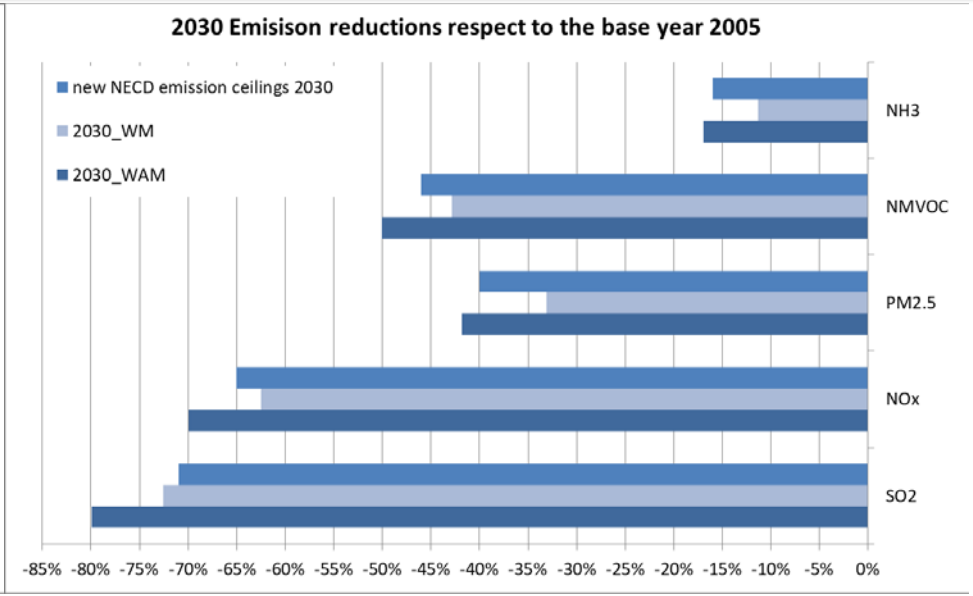
Emission and Air Quality Scenarios for the NEC Directive

Integrated Assessment Modelling System



Compliance with IT Emission Ceilings (NECD)





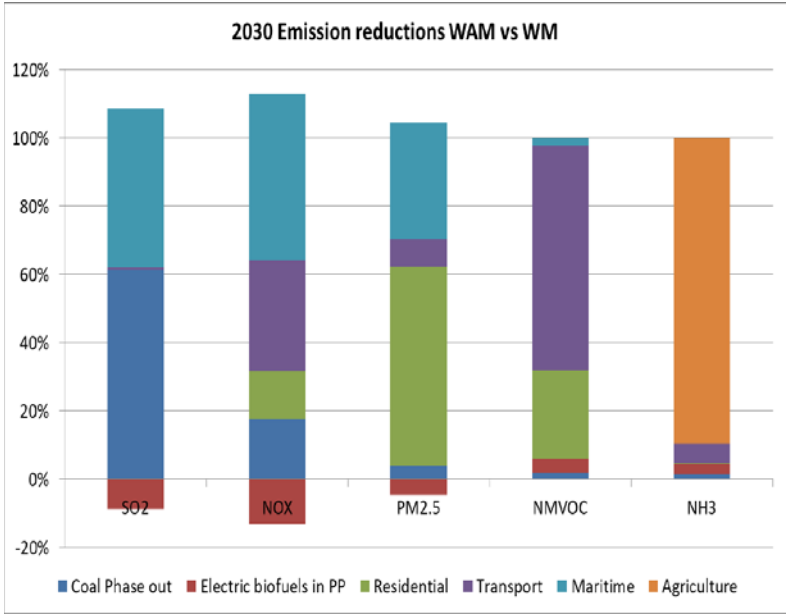
2020 Ceilings: compliance with WM

2030 Ceilings: non compliance for WM (all pollutants but SO_2)
→ Additional measures needed

The WAM scenarios

Table 1. Measures adopted in the 2030 "With Additional Measures" (WAM) scenario.

Sector	Name	Description
Power plants	Coal phase–out	Gradual phasing–out of coal power plants to be completed by 2025
Residential/Services sector	Replacement of biomass systems	Renewal of old biomass heating systems with efficient and low–emission technologies
Residential/Services sector	Energy efficiency in buildings	Tighten minimum standards for building (for example, Nearly Zero Energy Buildings)
Transport	Public transport promotion	Promote public transportation to reduce private transport and renew bus fleet
Transport	Electric vehicles	Increase the spread of electric vehicles for private urban mobility
Transport ***& Maritime***	Renew fleet for freight vehicles	Promote the use of methane/liquefied natural gas (LNG)–powered heavy duty trucks. Promote the use of LNG in maritime transport
Agriculture	Incorporate fertilizers	Incorporate urea–based fertilizers
Agriculture	Ban on new waste lagoons	Ban on constructing new waste lagoons
Agriculture	Slurry	Measures to reduce spread slurry and its incorporation
Agriculture	Spreading of solid manure	Incorporation of manure distributed on the surface



Health impact: mortality

$$Cases_{Poli}^{mortality} = M_0 \times P_j \times \left(e^{\beta_{Poll}\Delta_{Polj}} - 1\right)$$

(Orru et al., 2013
Martenies et al., 2015)

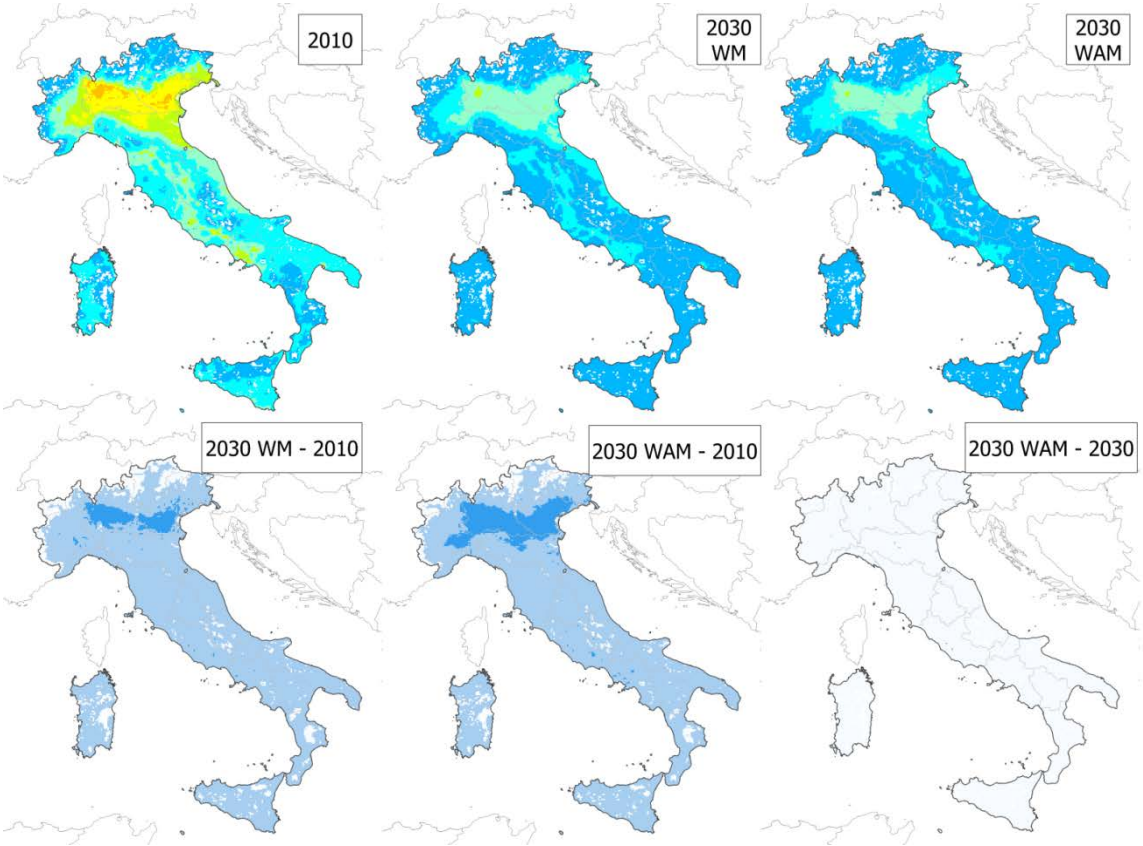
Pollutant Metric	Health Outcome	2010 (min–max)	2030 WM (min–max)	2030 WM–2010 (%)	2030 WAM (min–max)	2030 WAM– 2010 (%)	WAM–WM (%)
$PM_{2.5}$ annual mean	Mortality all–natural causes	58,867 (35,379–83,670)	37,335 (22,608–52,656)	−37%	34,666 (21,013–48,840)	−41%	−7%
	Mortality cardiovascular diseases	46,960 (22,936–72,106)	26,817 (13,392–40,277)	−43%	22,847 (11,427–34,264)	−51%	−15%
	Mortality respiratory diseases	7396 (0–18,948)	4223 (0–10,173)	−43%	3598 (0–8632)	−51%	−15%
	Mortality lung cancer	4040 (1753–6436)	2337 (1037–3642)	−42%	2168 (964–3372)	−46%	−7%
NO_2 annual mean	Mortality all–natural causes	11,769 (6566–17,301)	1727 (972–2513)	−85%	793 (449–1149)	−93%	−53%
O_3 April–September mean of MDA8	Mortality respiratory diseases	2692 (945–4702)	1851 (654–3211)	−31%	1725 (610–2990)	−36%	−7%

Health impact: mortality

Pollutant Metric	Health Outcome	2010 (min–max)	EEA, 2011	VIIAS, 2015
$PM_{2.5}$ annual mean	Mortality all–natural causes	58,867 (35,379–83,670)	64,544 (42,650-84,475)	21,524 (counterfactual: 10 µg/m^3)
	Mortality cardiovascular diseases	46,960 (22,936–72,106)		
	Mortality respiratory diseases	7396 (0–18,948)		
	Mortality lung cancer	4040 (1753–6436)		
NO_2 annual mean	Mortality all–natural causes	11,769 (6566–17,301)		11,993
O_3 April–September mean of MDA8	Mortality respiratory diseases	2692 (945–4702)		1,858

Fair agreement with previous national-scale HIAs

Health impact: mortality rate, PM2.5



nd variations between 2010,

030 WAM–2010 (%)	WAM–WM (%)
−39%	−6%
−35%	−7%
−35%	−6%
−34%	−7%
−39%	−17%
−40%	−7%

Cost assessment

- Years Of Life Lost = $N_{attributable\ cases}$ x Average Years Lost → 10.3 (Holland, 2014)

(per model grid cell)

- average Value Of a Life Year :

(per administrative Region)

$$VOLY_j = VOLY_{ref}\left(\frac{GDP_j}{GDP_{EU}}\right)^{\beta}$$ → CE Delft, 2018

Outcome	Age Group	Adjusted Reference Value (EU28) (€2010)	Adjusted Value for Italy (€2010)	Reference Value (€2005)
Premature deaths (value of a year of life lost)	>30 years	62,633/144,371	88,930/204,986	57,000/133,000 [50]
Income elasticity is 0.8 for adjustment				

Holland, 2014

- Cost = YOLL x VOLY

(per administrative Region)

Cost assessment

Table S4. Total and per pollutant damage-costs (mln €) of the base year 2010.

REGIONS	2010			
	$PM_{2.5}$ costs (mln €)	NO_2 costs (mln €)	O_3 costs (mln €)	TOT costs (mln €)
Abruzzo	889 (537-1258)	0 (0-0)	43 (15-74)	932 (552-1332)
Basilicata	235 (143-331)	0 (0-0)	13 (5-23)	248 (147-354)
Calabria	683 (415-961)	0 (0-0)	48 (17-83)	731 (431-1044)
Campania	3652 (2199-5180)	717 (403-1045)	185 (65-325)	4554 (2667-6549)
Emilia-Romagna	5454 (3271-7769)	688 (388-1001)	209 (73-365)	6351 (3732-9135)
Friuli-Venezia Giulia	1297 (779-1845)	36 (20-52)	52 (18-90)	1385 (818-1987)
Lazio	5568 (3356-7889)	2061 (1155-3014)	306 (107-537)	7935 (4619-11440)
Liguria	1286 (776-1820)	131 (74-190)	83 (29-146)	1501 (880-2156)
Lombardia	16313 (9733-23359)	7296 (4046-10796)	523 (184-914)	24132 (13962-35069)
Marche	1183 (714-1674)	0 (0-0)	59 (21-104)	1242 (735-1778)
Molise	156 (95-221)	0 (0-0)	9 (3-15)	165 (98-235)
Piemonte	4145 (2495-5884)	973 (545-1423)	172 (61-301)	5291 (3101-7608)
Puglia	1772 (1073-2498)	0 (0-0)	112 (39-195)	1883 (1112-2693)
Sardegna	738 (447-1040)	0 (0-0)	44 (16-77)	782 (463-1117)
Sicilia	1835 (1114-2582)	0 (0-0)	143 (50-250)	1978 (1164-2832)
Toscana	3009 (1816-4259)	65 (37-94)	167 (59-292)	3241 (1912-4645)
Trentino-Alto Adige	461 (279-650)	10 (5-14)	21 (7-36)	491 (292-700)
Umbria	679 (410-962)	0 (0-0)	29 (10-51)	709 (420-1013)
Valle D'Aosta	60 (36-84)	0 (0-0)	3 (1-5)	63 (37-89)
Veneto	6284 (3760-8971)	501 (283-727)	226 (79-395)	7011 (4122-10094)
ITALY	53921 (32406-76640)	10780 (6014-15848)	2466 (866-4307)	67167 (39287-96794)

Cost assessment

Table 11. Total and per pollutant benefit–costs (mln €) of the 2030-WM scenario, compared to the base year 2010, and of the 2030-WAM scenario, compared to the 2030 WM; incidence of the benefits as percentage of the regional and national GDP2010.

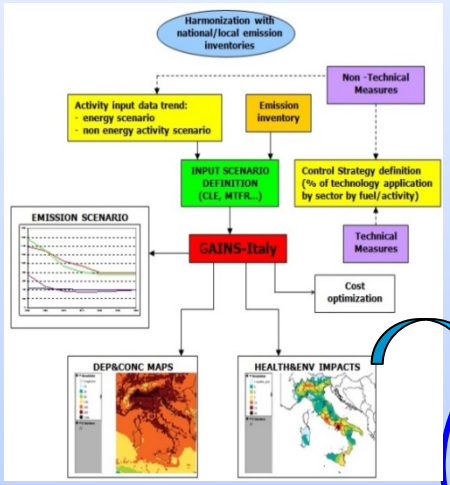
Regions	Benefits 2030 WM–2010(mln €)	Additional Benefits WAM–WM (mln €)	2030 WM–2010 % of GDP2010	WAM–WM % of GDP2010
Abruzzo	350 (205–506)	44 (26–64)	1.14%	0.14%
Basilicata	83 (49–119)	7 (4–10)	0.74%	0.06%
Calabria	242 (142–349)	22 (13–32)	0.73%	0.07%
Campania	2122 (1227–3079)	157 (92–227)	2.06%	0.15%
Emilia–Romagna	2617 (1510–3814)	311 (183–449)	1.90%	0.23%
Friuli-Venezia Giulia	510 (297–741)	60 (35–86)	1.46%	0.17%
Lazio	4163 (2388–6056)	310 (180–448)	2.22%	0.17%
Liguria	638 (371–924)	73 (43–105)	1.38%	0.16%
Lombardia	11,925 (6773–17,575)	1697 (973–2472)	3.41%	0.49%
Marche	465 (272–674)	53 (31–77)	1.18%	0.14%
Molise	59 (35–85)	6 (3–8)	0.88%	0.09%
Piemonte	2382 (1377–3461)	364 (212–524)	1.91%	0.29%
Puglia	667 (389–964)	50 (29–72)	0.95%	0.07%
Sardegna	250 (147–361)	16 (10–24)	0.76%	0.05%
Sicilia	663 (386–960)	36 (20–53)	0.75%	0.04%
Toscana	1210 (705–1753)	149 (88–215)	1.15%	0.14%
Trentino-Alto Adige	187 (110–269)	21 (13–30)	0.98%	0.11%
Umbria	250 (146–362)	32 (19–46)	1.13%	0.15%
Valle D'Aosta	21 (12–30)	3 (2–4)	0.44%	0.06%
Veneto	2944 (1705–4293)	354 (208–512)	2.06%	0.25%
ITALY	29,691 (17,088–43,320)	3415 (1981–4947)	1.84%	0.21%

Some conclusions

- Despite no bias correction on concentrations (for avoiding distortions on scenario variations), fair agreement of mortality with previous Italian-scale studies
- WM impacts substantially on the number of expected deaths
- The absolute number of avoided events from PM2.5 is more than the double of that from NO_2, despite a lower value of the relative reduction (higher exposure of population to PM2.5 = higher potential in reducing mortality)
- WM and WAM reach almost the maximum avoidable events due to NO_2
- NO_2: variation of mortality rate much lower than that of absolute mortality, due to higher concentrations reductions in densely populated grid cells (urban)
- WAM brings an economical benefit equal to 2,05 % of Italian 2010 GDP, mainly in the Po Valley hot-spot, but not negligible (>1%) in several regions

Very quick update on GAINS-Italy developments

The new GAINS-IT model



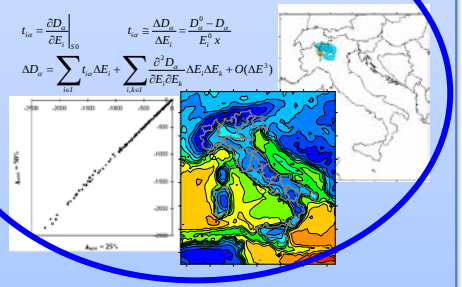
Energy model

(Markal, TIMES, PRIMES…)

Air quality models (ATMs)

$$t_{i\alpha} = \frac{\partial D_\alpha}{\partial E_i}\Big|_{S0} \qquad t_{i\alpha} \cong \frac{\Delta D_\alpha}{\Delta E_i} = \frac{D_\alpha^0 - D_\alpha}{E_i^0 x}$$

$$\Delta D_\alpha = \sum_{i\alpha 1} t_{i\alpha} \Delta E_i + \sum_{i,k\alpha 1} \frac{\partial^2 D_\alpha}{\partial E_i \partial E_k} \Delta E_i \Delta E_k + O(\Delta E^3)$$



THE OLD MODEL
- Input data: The 20 Italian Regions
- ATM spatial resolution: 20 km
- Meteo: 1999, 2003, 2005, 2007 + avg
- ATM equation: linear + second order terms for O_3 impact indicators
- Scenario years: 1990-2030 (5-year step)

The new GAINS-IT model

A new project ENEA – IIASA to update the GAINS-IT model and the opt tool

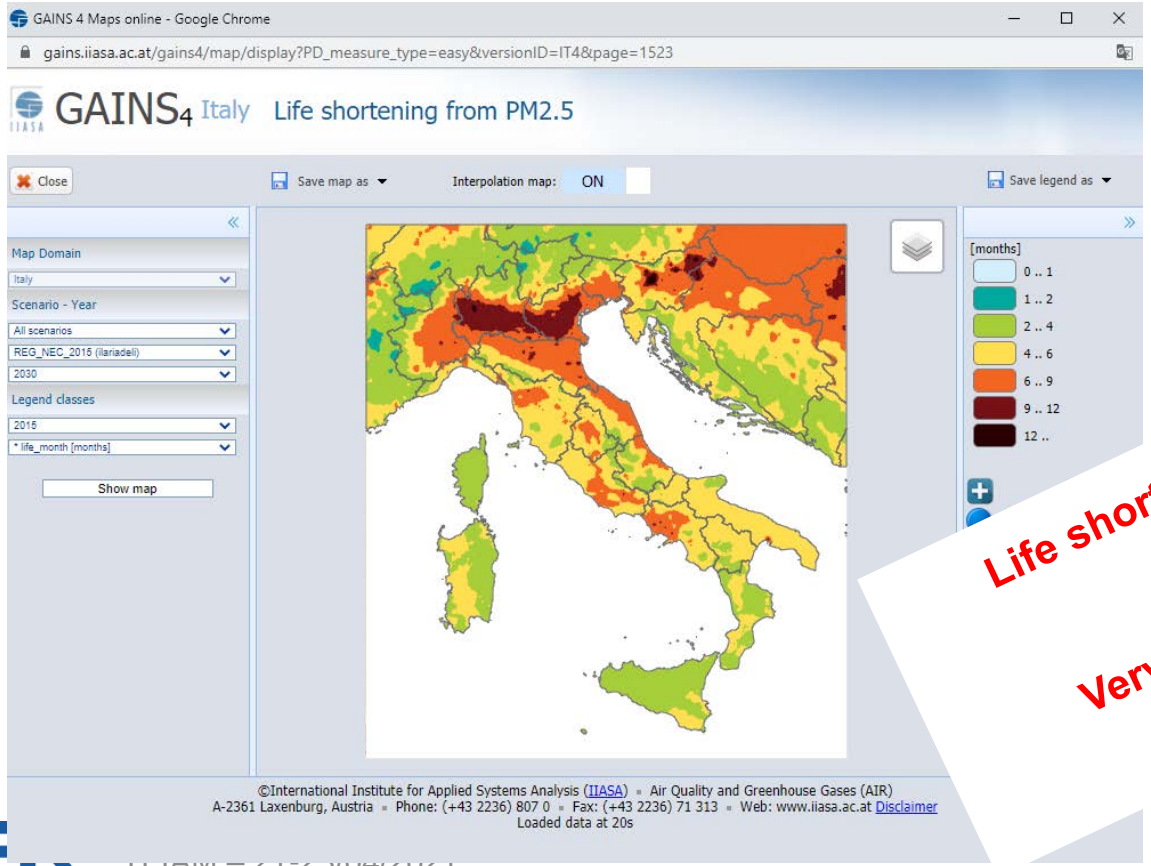
ENEA team:
Ilaria D'Elia (coord), Antonio Piersanti, Gino Briganti, Andrea Cappelletti, Luisella Ciancarella

IIASA team:
Robert Sander (coord), Gregor Kiesewetter, Wolfgang Schoepp, Binh Nguyen, Fabian Wagner

First results by the end of 2021

THE NEW MODEL
- Input data: The 20 Italian Regions
- ATM spatial resolution: 4 km
- Meteo: 2015, 2004, 2005 + avg
- ATM equation : linear + second order terms some impact indicators (O_3, PM, NO_2…)
- Scenario years: 1990-2050 (5-year step)

The new GAINS-IT model



Life shortening from PM2.5

Year 2030

Very preliminary results

(resolution 4km)

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