Milan Air Quality observations and Lessons Learnt from COVID lockdown

Silvia Moroni, PhD
Paolo Palomba

AMAT - Agenzia Mobilità Ambiente e Territorio, City of Milan

IX Giornata sulla Modellistica in ARIA(NET)

Milano, May 6th, 2022

Comune di Milano

AGENZIA MOBILITÀ AMBIENTE TERRITORIO

Milan, an inclusive city

Actions to reduce sources of air pollution and get citizens to adopt aware lifestyles

1.4 million
inhabitants

7,518
Inh./km2

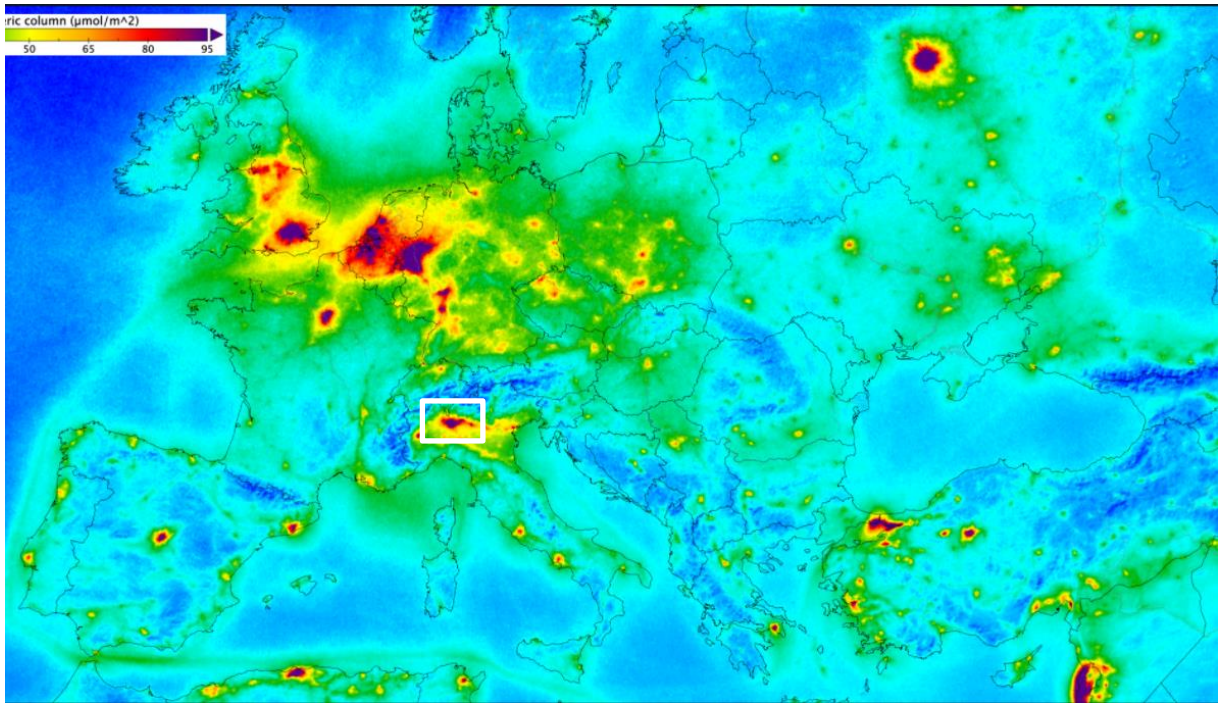
800,000
Commuters/day

6,8 millions
Tourists in 2018 (ISTAT)

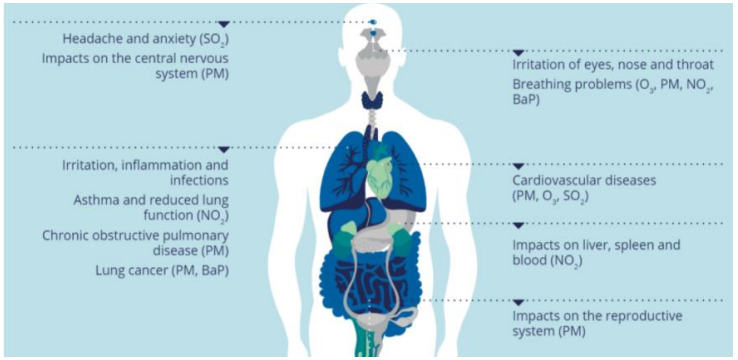
3,1 tonnes/capita
GHG in 2020

Air Quality in Milan

Air quality is one of the most important **environmental and health issues** for the City of Milan - together with the whole Po Valley - affected by strong unfavorable meteorological conditions



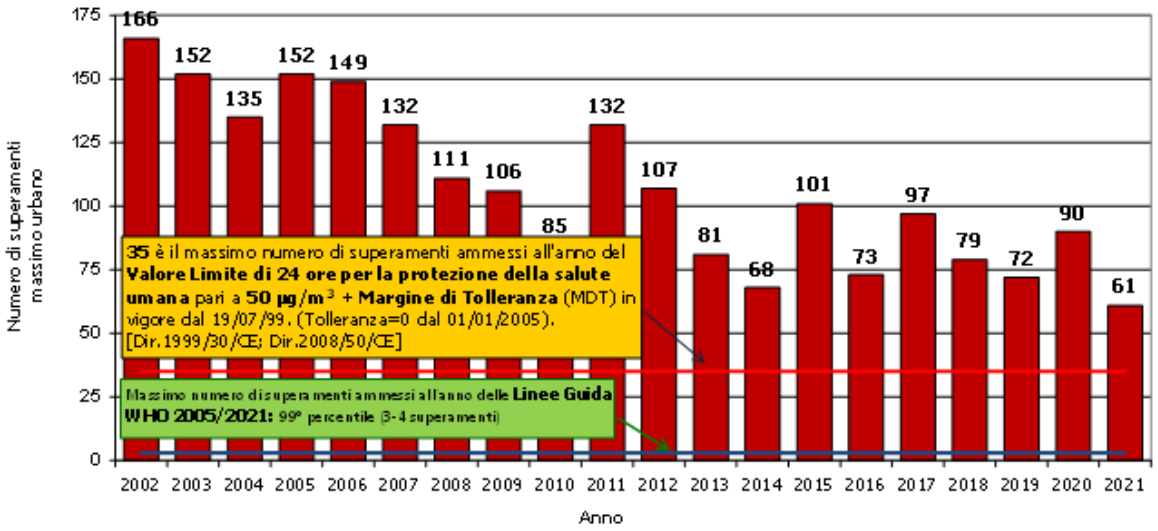
Nitrogen dioxide concentrations in Europe (Source: ESA, 2019)



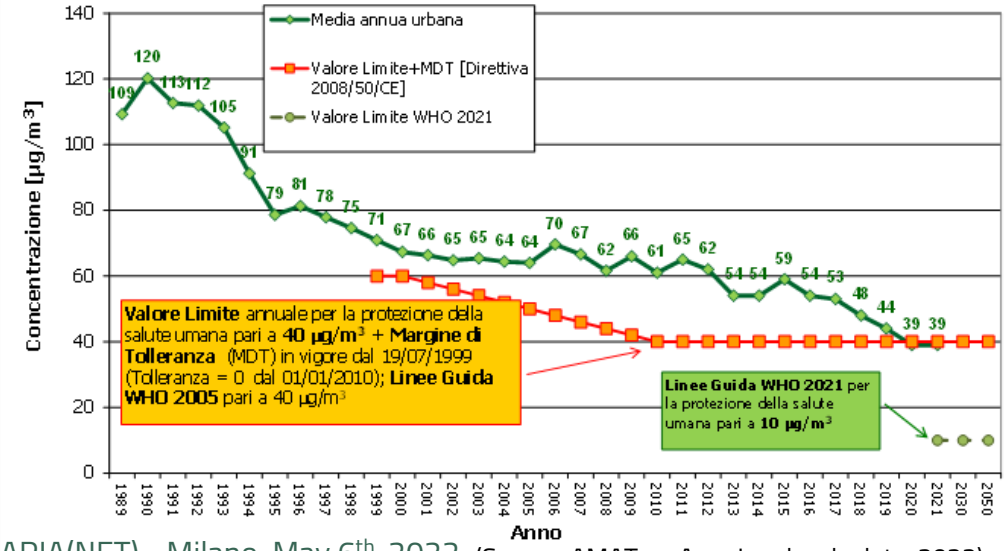
Health impacts of air pollution (Source: EEA, 2019)

In Milan, as in Po Valley, **2-3 years of years of life lost / inh.** due to exposure to concentrations not in compliance with EU Limit Values and WHO Guidelines

PM10 - Annual Number of exceedances davs



Nitrogen dioxide (NO_2)



(Source: AMAT on Arpa Lombardy data, 2022)

Milan: Air Quality and Climate Challenges

Annual average 2020		WHO 2005 Guidelines
PM_{10} : 34 µg/m3	›	20 µg/m3
$PM_{2,5}$: 24 µg/m3		10 µg/m3
NO_2 : 39 µg/m3	›	40 µg/m3
O_3 : 116 exceeding days		0 exceeding days

New WHO 2021 Guidelines

Source: AMAT data processing on Arpa Lombardia data

+2°C
Average Annual Temperature
(1901-2017)

over 2°C _ Summer
over 1°C _ Winter

Projection to 2050 of the maximum and minimum temperature increase

Source: Profile Climatico Locale, Arpa Lombardia e Arpa Emilia Romagna, Comune di Milano

The City Council declared
a Climate and Environmental Emergency
in May 2019

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AGENZIA MOBILITÀ AMBIENTE TERRITORIO

Milan Air Quality and Climate Plan Targets

City Council Resolution no. 4 of February 21, 2022

Integrated approach

→ **Air Quality Goals:**

Short term

✓ ***By 2021*** *fix an AQ strategy for compliance with WHO Guidelines for all pollutants on long term*

Medium Term

✓ ***By 2025*** *compliance with EU AQ Limit Values for PM10, PM2.5 and* NO_2

Long Term

✓ ***By 2050*** *approach WHO AQ Guidelines*

→ **Climate Change Goals:**

✓ ***By 2030*** *-45%* CO_2 *emissions vs 2005*

✓ ***By 2050*** *Carbon neutrality*

Air Quality and Climate Plan

Vision to 2050, for a **City of Milan:**

01 **Healthy and Inclusive Milan**: a healthier, safer and more equitable City.

02 **Connected and highly accessible Milan:** a well connected and flexible City, with smooth and sustainable mobility

03 **Positive Energy Milan**: a City that consumes less and consumes energy better

04 **Cool Milan:** a greener city, cooler and liveable, which adapts to climate change

05 **Aware Citizens**: a City which adopts an aware and sustainable lifestyle

Air Quality and Climate Plan

2. Connected and highly accessible Milan

A well connected and flexible City with smooth and sustainable movements.

Vision 2050: transform personal mobility in active mobility giving priority to bicycles and pedestrians.

Goal 2030: highly reduce motorised private traffic

1. Strengthening existing LEZs (Low Emission Zone) to reduce air emissions
2. Planning actions and agreements for sustainable mobility (promote sharing at urban scale, policy for public transport, etc)
3. Setting a Zero Emissions Zone
4. Implementing a Carbon-neutral area

Comune di Milano

AGENZIA MOBILITÀ AMBIENTE TERRITORIO

Limited Traffic Zones in Milan

'Area C': the Milan Congestion Charge

-30% traffic;

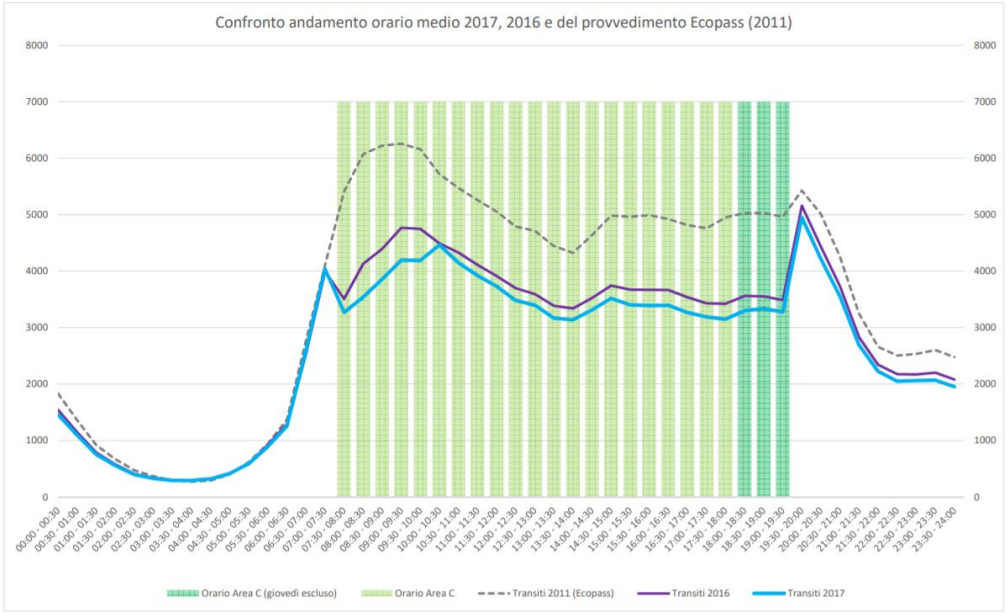
-28% road accidents

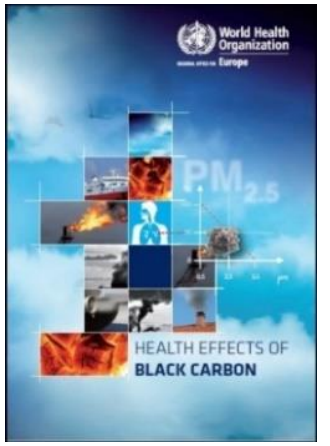
-49% most polluting vehicles

-19% PM_{10} exhaust emissions

-10% NO_x emissions

-22% CO_2 emissions





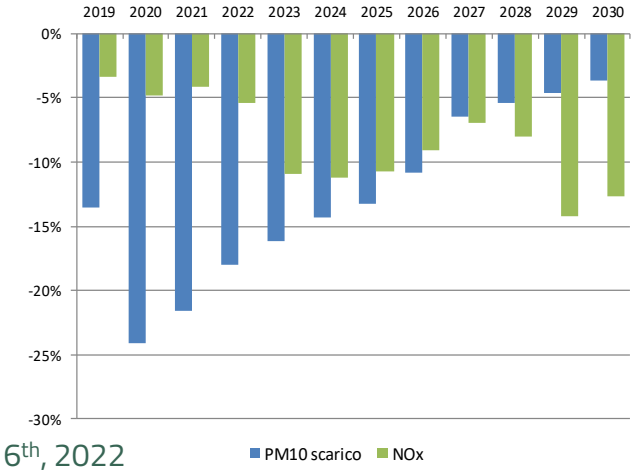
Pilot project:

- 52% Black Carbon concentrations inside Area C

'Area B': the Milan Low Emission Zone

- 50% PM_{10} exhaust emissions within 4 years

- 50% NO_x traffic emissions within 10 years



Starting from October 1st, 2021 Area B is fully coordinated with the **MoVe-In** Lombardy Region initiative

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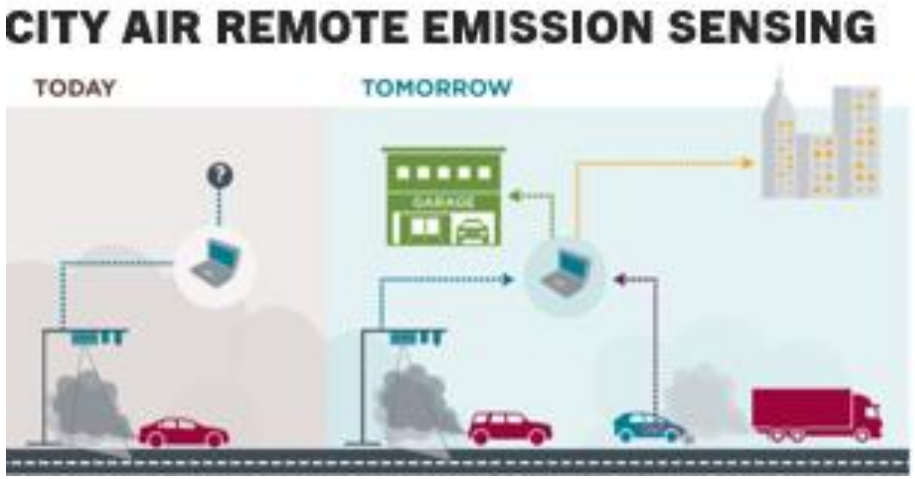
European co-funded projects

CARES
CITY AIR REMOTE EMISSION SENSING



https://cares-project.eu/

LIFE REMY
Reducing Emission Modelling uncertaintY

https://liferemy.eu/

Lesson learned from Covid-19 lockdown in Milan

Results from two studies on Covid-19 lockdown in Milan

ELSEVIER

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[a] University of Southern California, Department of Civil and Environmental Engineering, Los Angeles, CA, USA
[b] Agenzia Mobilità Ambiente e Territorio - AMAT srl, Mobility, Environment and Territory Agency, Milan, Italy
[c] Fondazione IRCCS Istituto Nazionale dei Tumori, Milan, Italy
[d] Associazione Medici per l'Ambiente ISDE Italia, International Society of Doctors for the Environment (ISDE), Italy

Traffic reductions in Milan

March 2020

Source: AMAT

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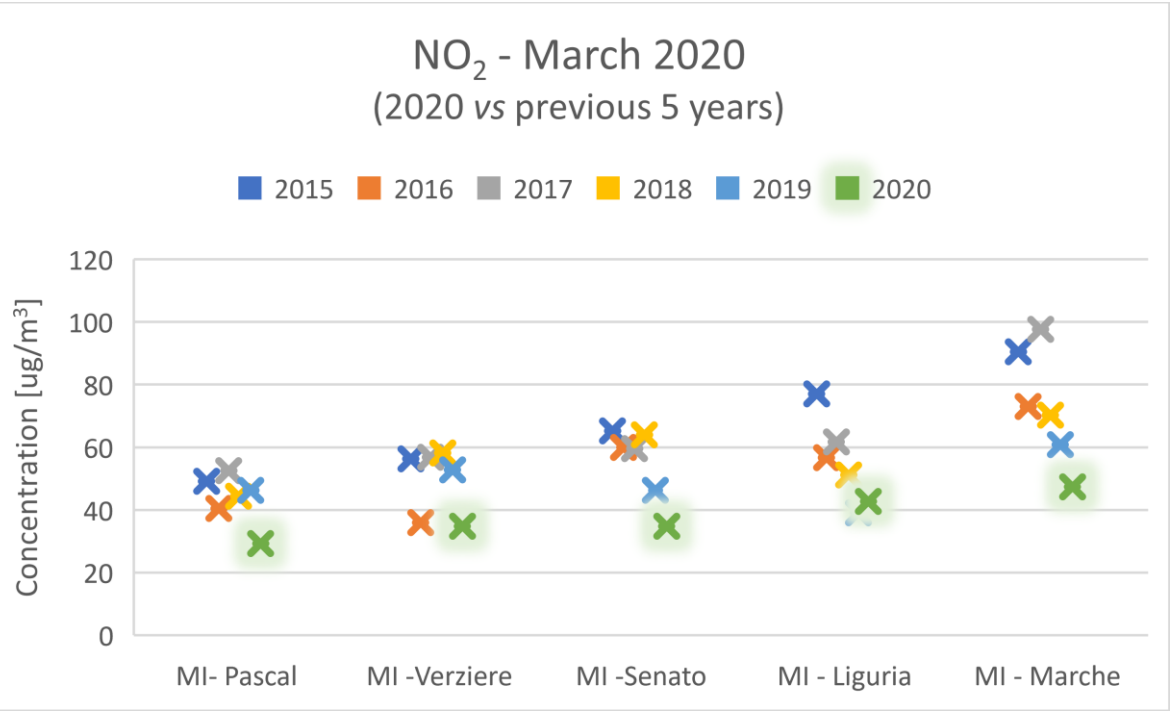
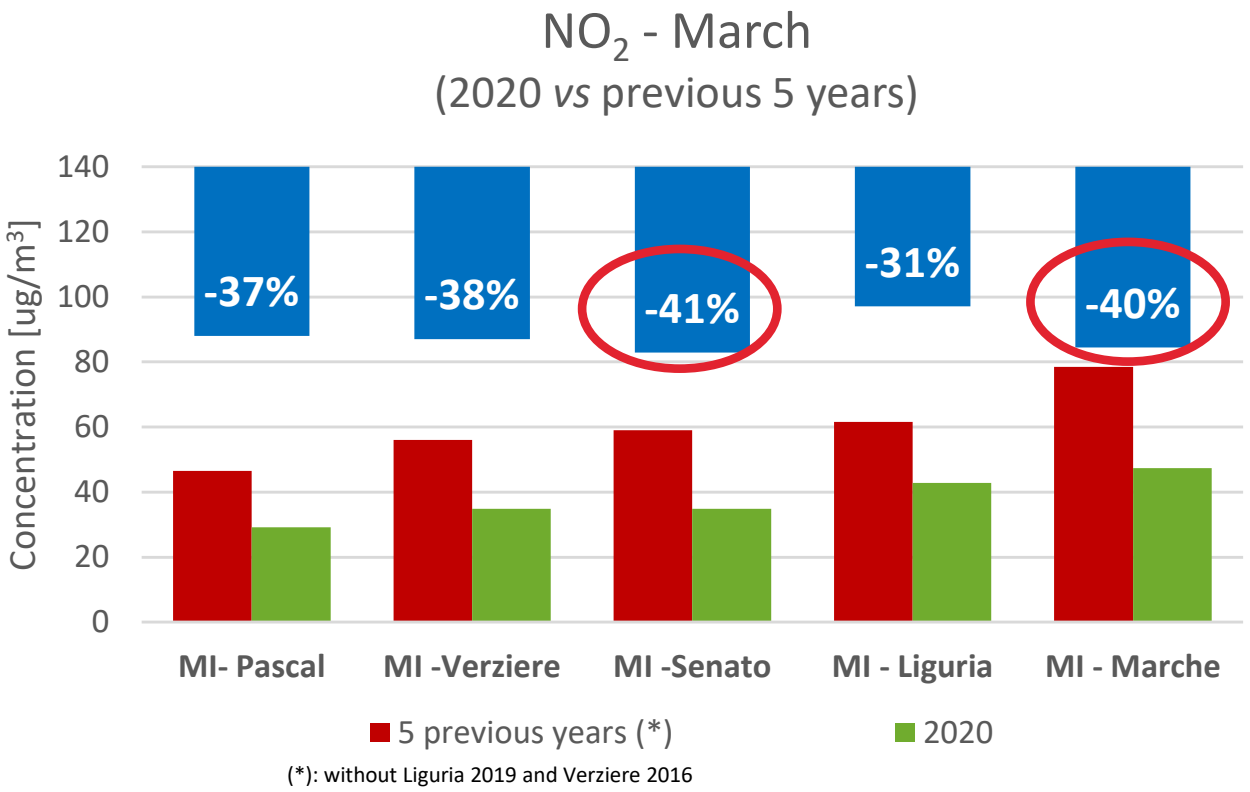
Nitrogen dioxide (NO_2)





(*): without Liguria 2019 and Verziere 2016

Source: AMAT, 2020, 'COVID-19 LOCKDOWN' ED EFFETTI SULLA QUALITÀ DELL'ARIA A MILANO: ANALISI INTEGRATA DATI QUALITA' DELL'ARIA, METEOROLOGICI E TRAFFICO VEICOLARE in relazione ai provvedimenti relativi alla Emergenza COVID-19'

Nitrogen dioxide (NO_2)

With the contribution of the LIFE Programme of the European Union
LIFE 15 IPE IT 013
prepAIR Po Regions Engaged to Policies of Air

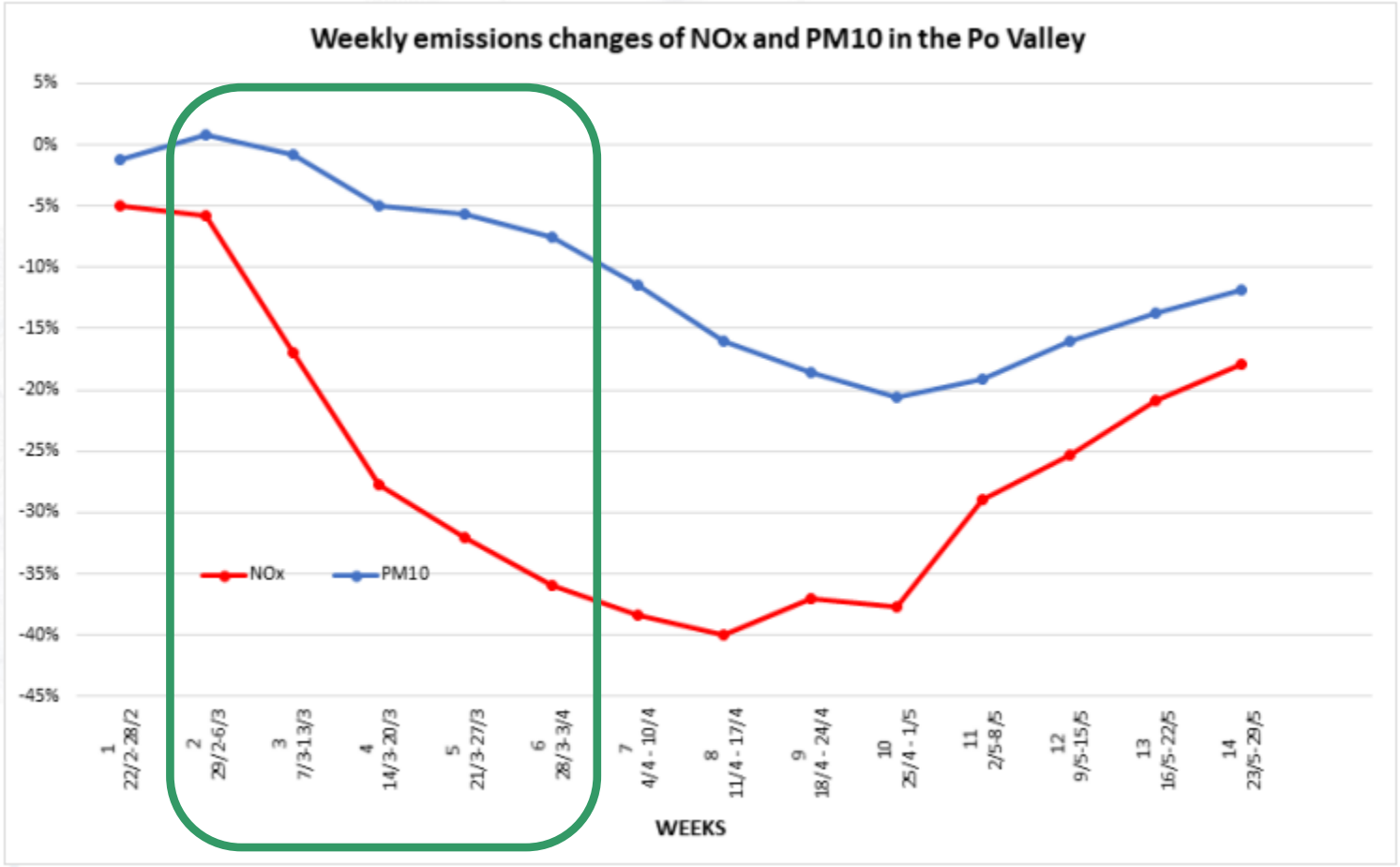


Figure1–Nox and PM10 weekly emission variations (%) in the Po Valley (February 22nd–May 29th2020)

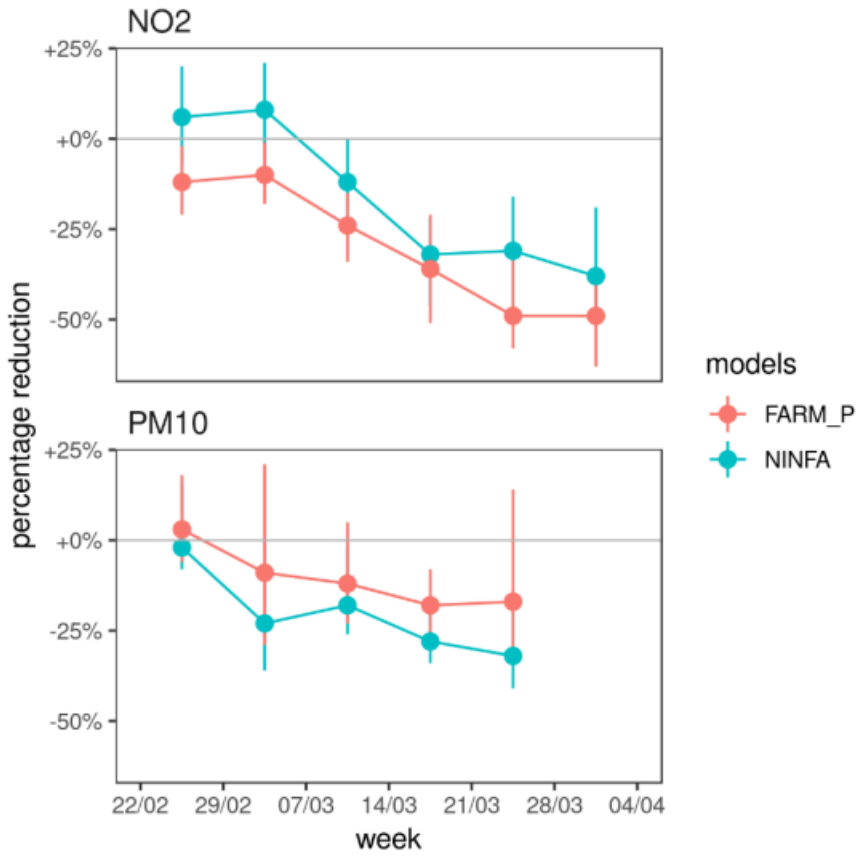
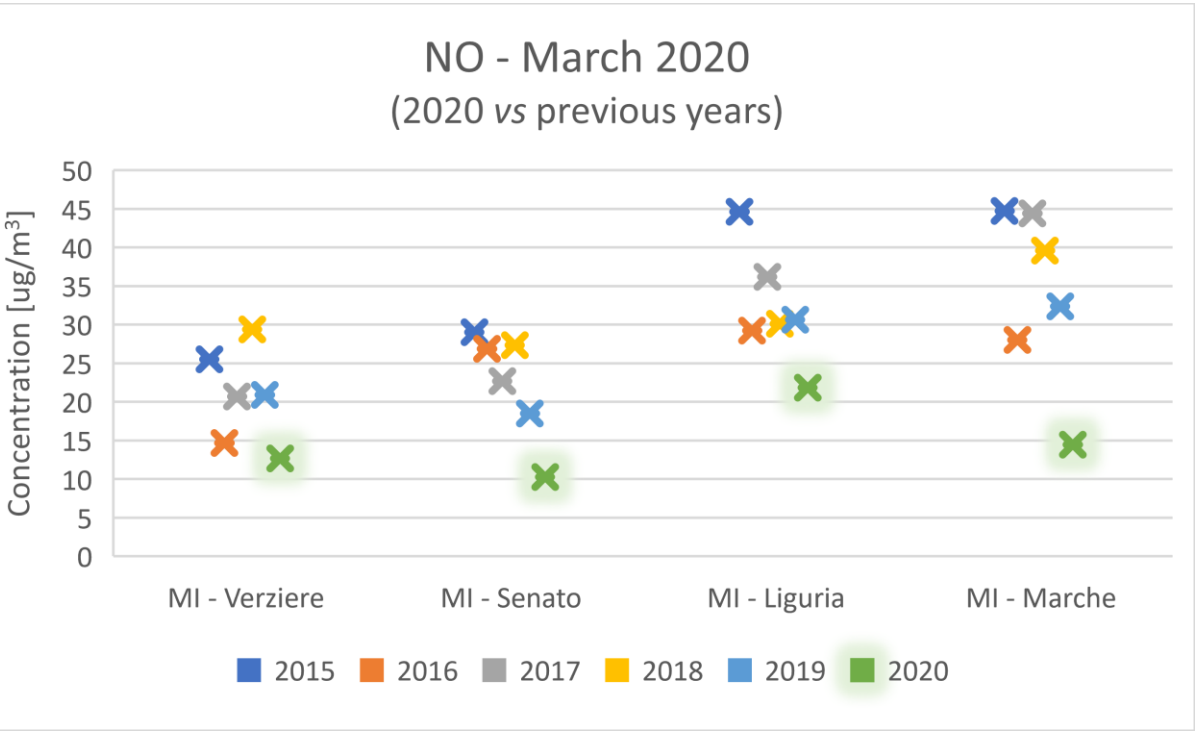


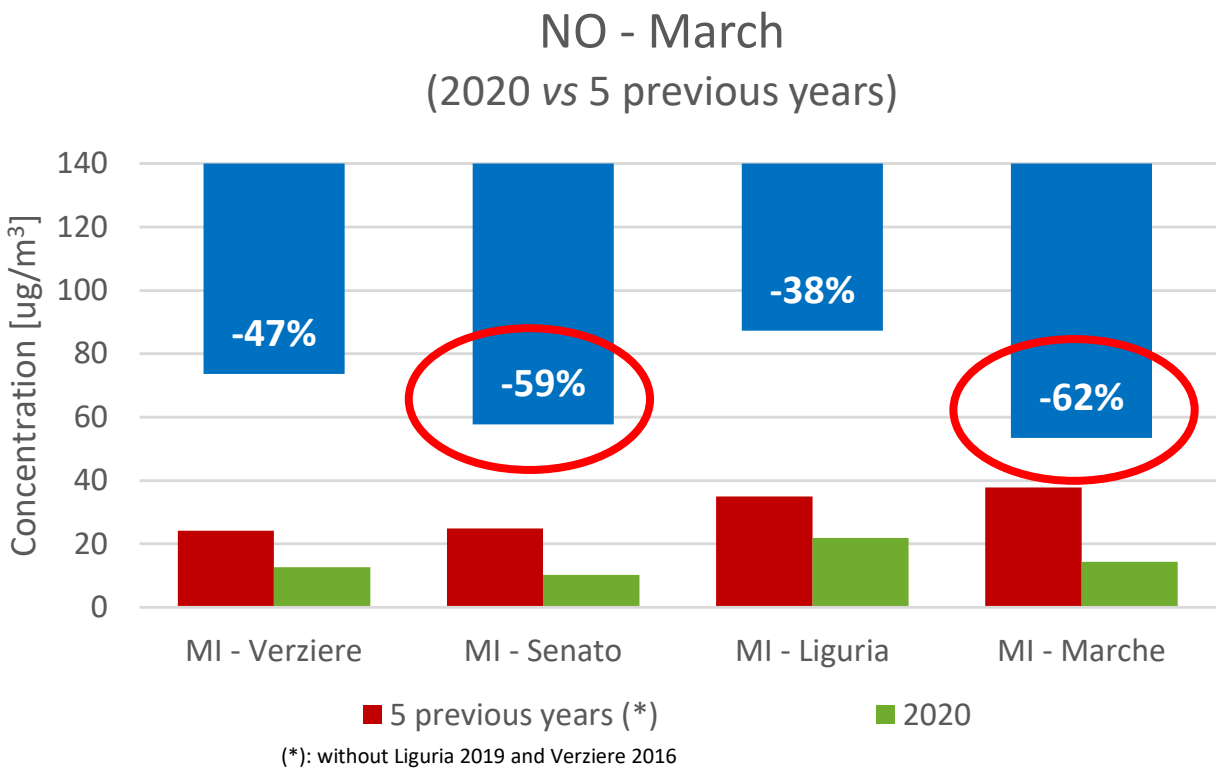
Figure 9 - Percentage reduction between real scenario and "NO-LOCKDOWN" scenario. NO2 above, PM10 below. The trends relating to the FARM_P model are shown in red, and NINFA in blue.

Source: PrepAir Project, 2020, 'Report 2 Covid-19 and air quality in the Po Valley Disclosure summary from January to May 2020'

Nitrogen Monoxide (NO)

NO, a 'primary' pollutant decreased more than NO_2





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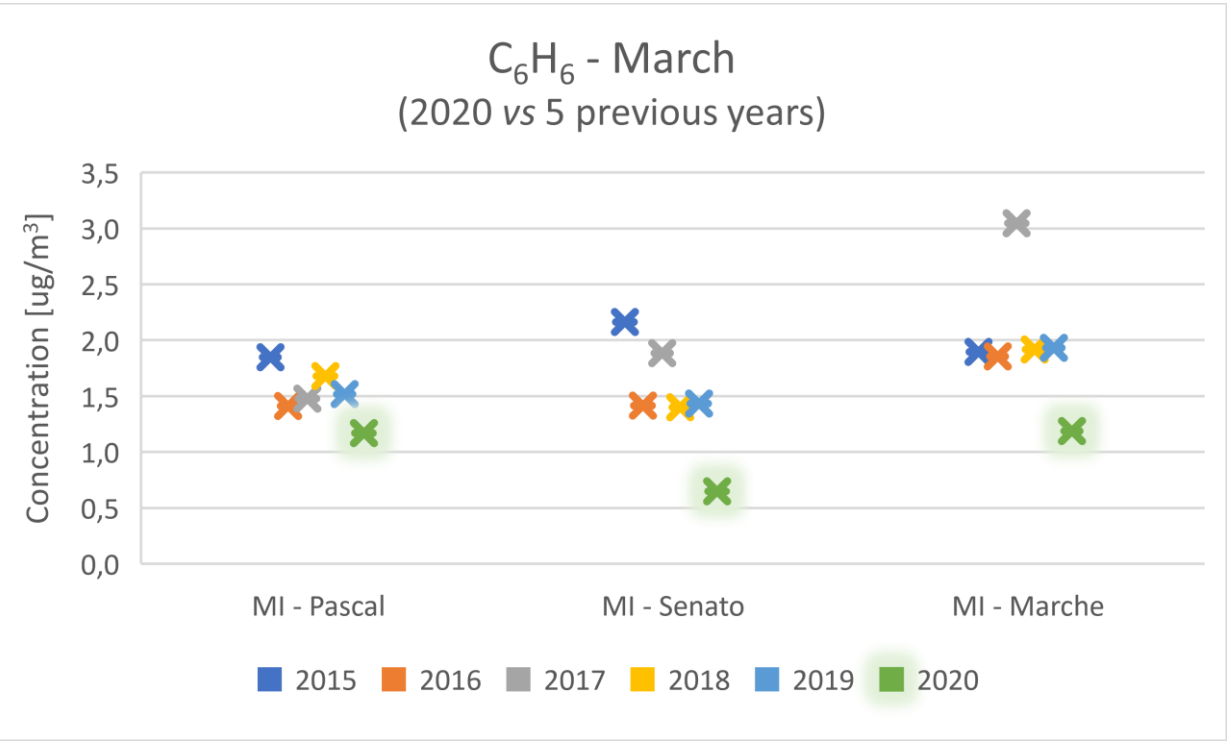
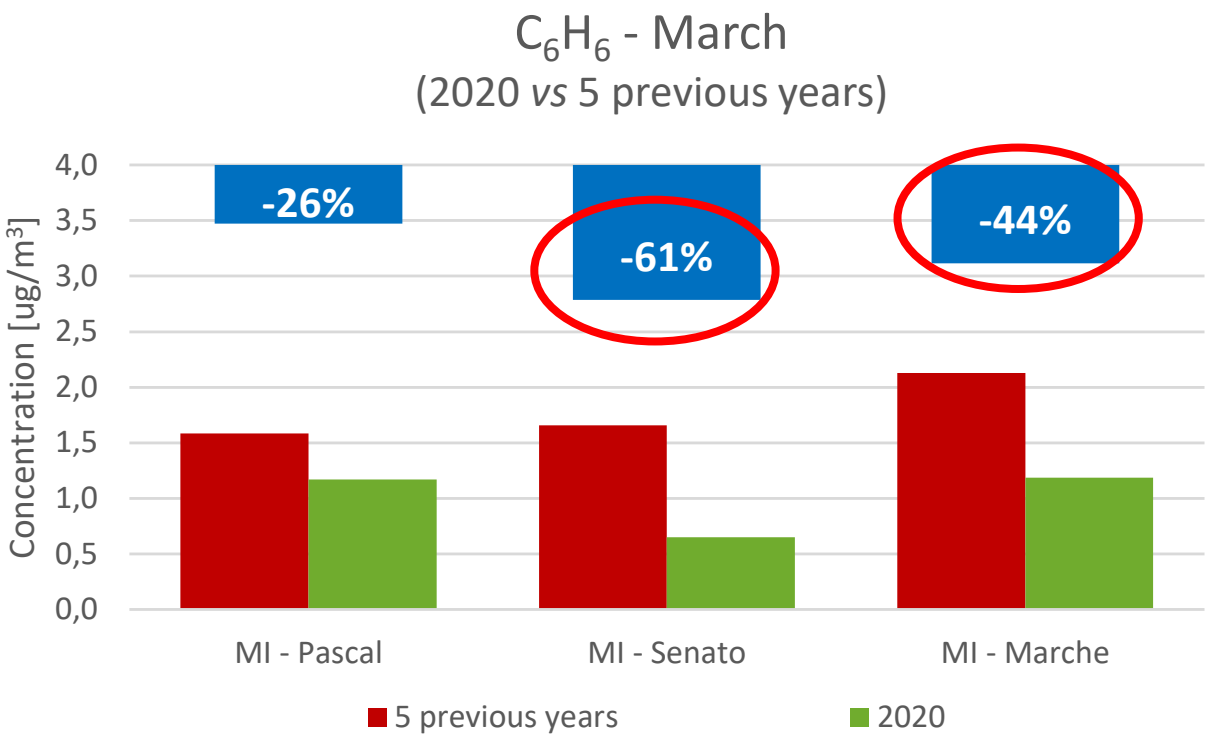
Benzene (C_6H_6)



Strong reduction of Benzene in traffic sites



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Covid Lockdown impacts on other pollutants

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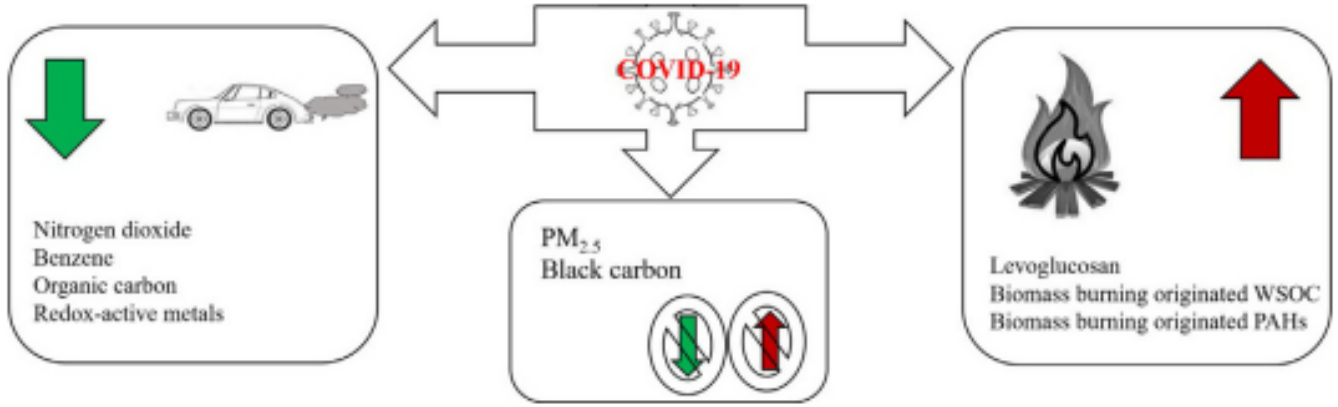
GRAPHICAL ABSTRACT



Source: A. Altuwayjiri, E. Soleimanian, S. Moroni, *et al.*, *The impact of stay-home policies during Coronavirus-19 pandemic on the chemical and toxicological characteristics of ambient PM2.5 in the metropolitan area of Milan, Italy*, Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2020.143582

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Covid Lockdown impacts on other pollutants

MAIN GOAL:

- to characterize changes in **components** and **toxicological properties of PM2.5** during the nationwide 2019-Coronavirus (COVID-19) lockdown restrictions in Milan
- analysis of **gaseous pollutants trend**

METHODOLOGY:

- ✓ Time-integrated **PM2.5 filters** were collected at a residential site in **Milan metropolitan area** from April 11th to June 3rd at 2020;
- ✓ pollutants determination: **EC/OC, water-soluble organic carbon (WSOC), individual organic species (**e.g., **polycyclic aromatic hydrocarbons (PAHs),** and **levoglucosan),** and **metals;**
- ✓ **institutional network data elaboration for gaseous pollutants**

Source: A. Altuwayjiri, E. Soleimanian, S. Moroni, *et al.*, *The impact of stay-home policies during Coronavirus-19 pandemic on the chemical and toxicological characteristics of ambient PM2.5 in the metropolitan area of Milan, Italy*, Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2020.143582

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MAIN FINDINGS

1. Nitrogen dioxide (**NO_2**) and benzene (**C_6H_6**) levels **significantly decreased** during the entire COVID-19 period compared to the same time span in 2019, mainly due to the government-backed **shutdowns** and **curtailed road traffic;**

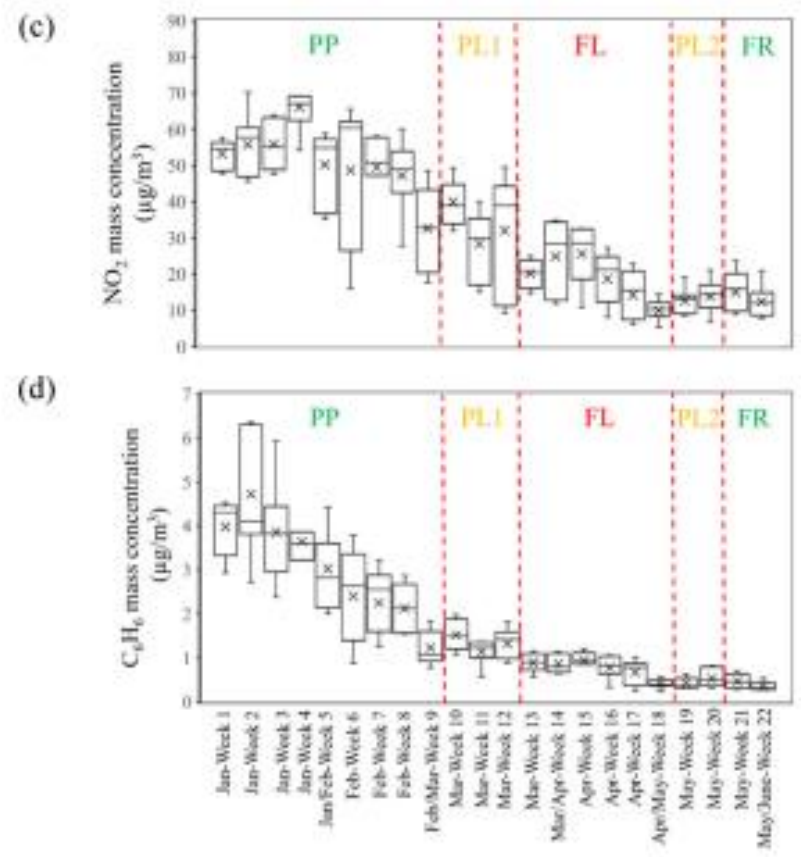

Fig. 1. Temporal trends in the concentrations of (a) $PM_{2.5}$; (b) BC; (c) NO_2; and (d) C_6H_6 from January 2020 to early-June 2020. Each box plot corresponds to the period of one week during pre-pandemic (PP), full-lockdown (FL), partial-lockdowns (PL1 and PL2), and full-relaxation (FR).

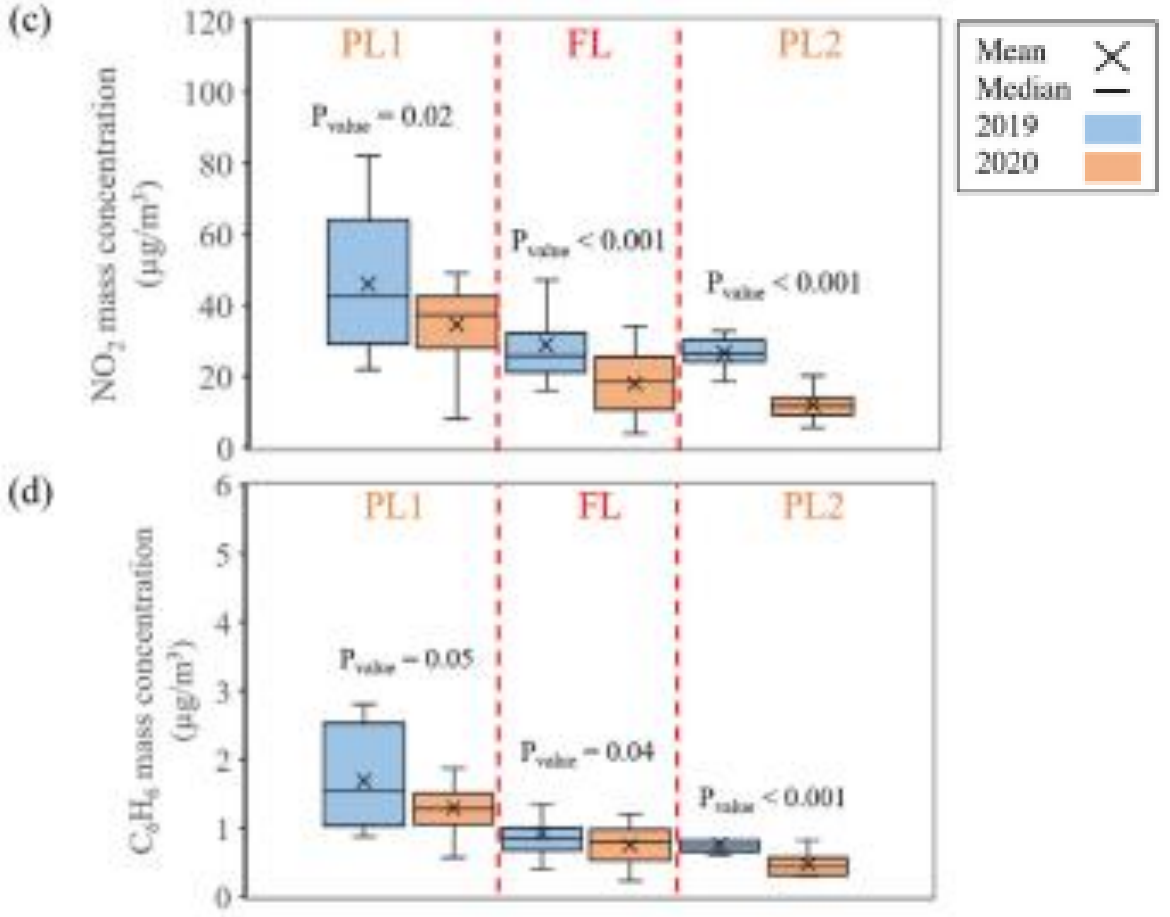

Fig. 2. Temporal trends in the concentrations of (a) $PM_{2.5}$; (b) BC; (c) NO_2; and (d) C_6H_6 during lockdown phase (i.e., PL1, FL, and PL2) of 2020 and the corresponding period in 2019.

Source: A. Altuwayjiri, E. Soleimanian, S. Moroni, *et al.*, *The impact of stay-home policies during Coronavirus-19 pandemic on the chemical and toxicological characteristics of ambient PM2.5 in the metropolitan area of Milan, Italy*, Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2020.143582

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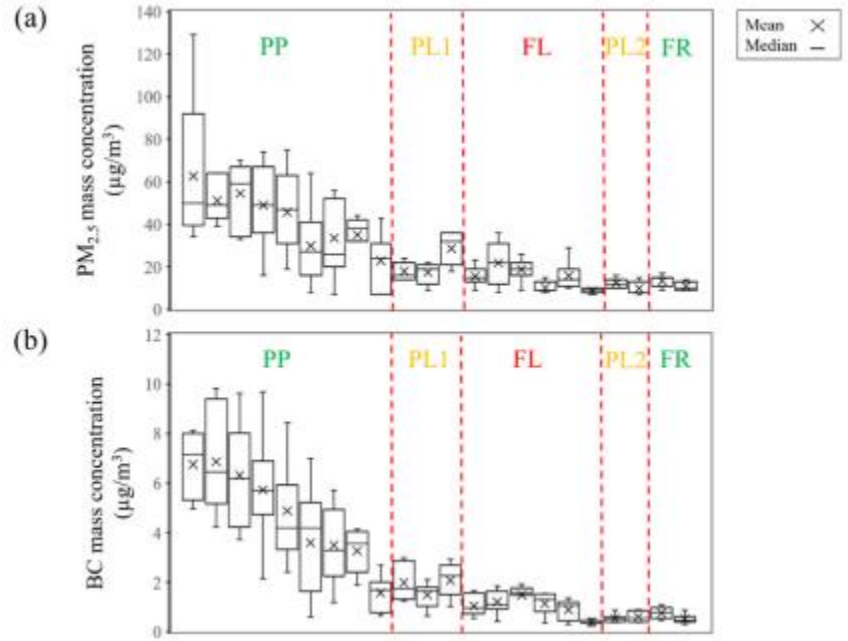
MAIN FINDINGS

2. In contrast, **comparable concentrations of ambient PM2.5 and black carbon (BC)** between lockdown period and the same time span in 2019 were attributed to the **interplay between decreased road traffic and elevated domestic biomass burning** as a result of **adopted stay-home strategies**.



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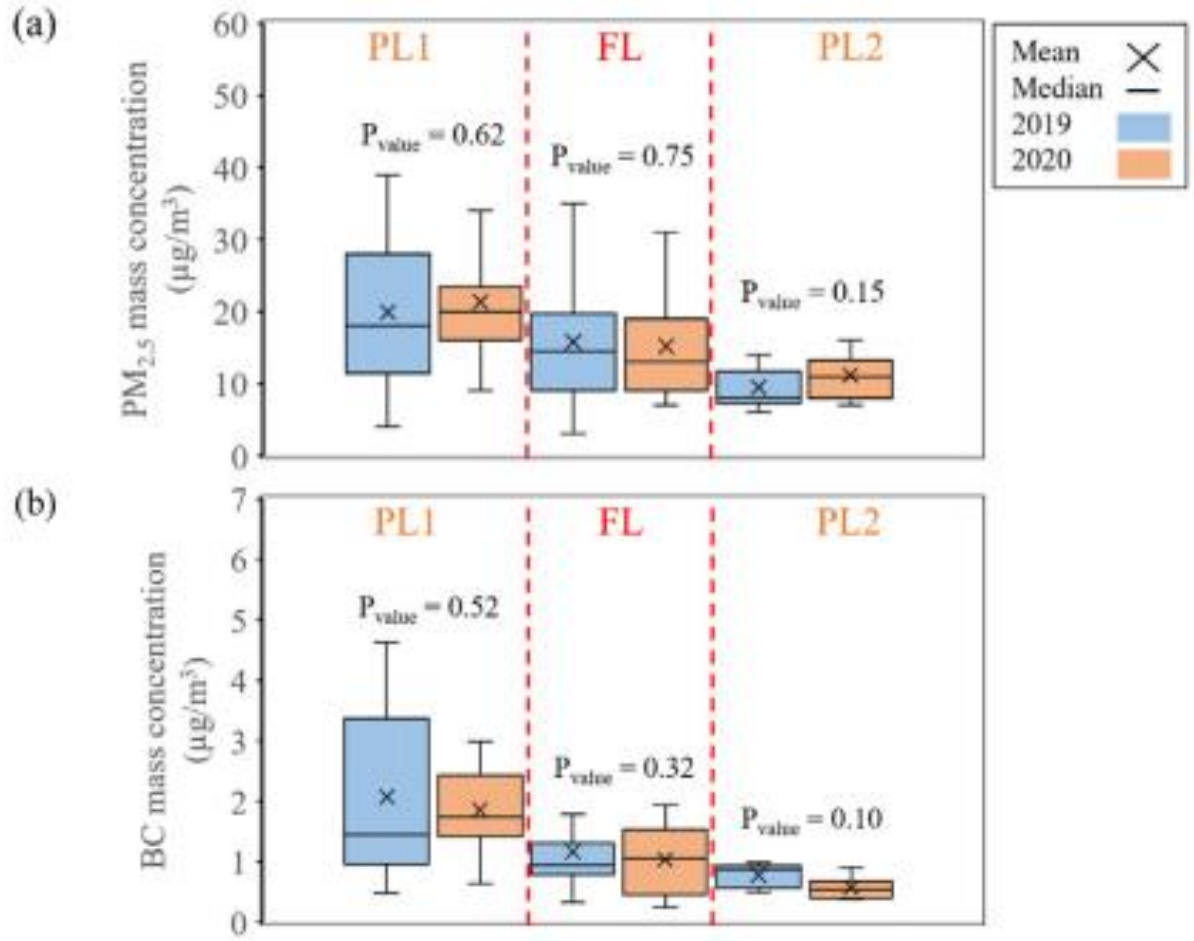

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Covid Lockdown impacts on other pollutants

MAIN FINDINGS

3. Observing **from FL and PL2 to FR period**: PM2.5-bound EC, as marker of traffic and biomass burning emissions remained almost constant, in agreement with BC concentrations; **PM2.5-bound OC mass concentration increased**; likewise ambient **WSOC increased by almost 40%** from FL and PL2 to FR period.

Normalized
vs
Air Volume

Normalized
vs
PM2.5 mass

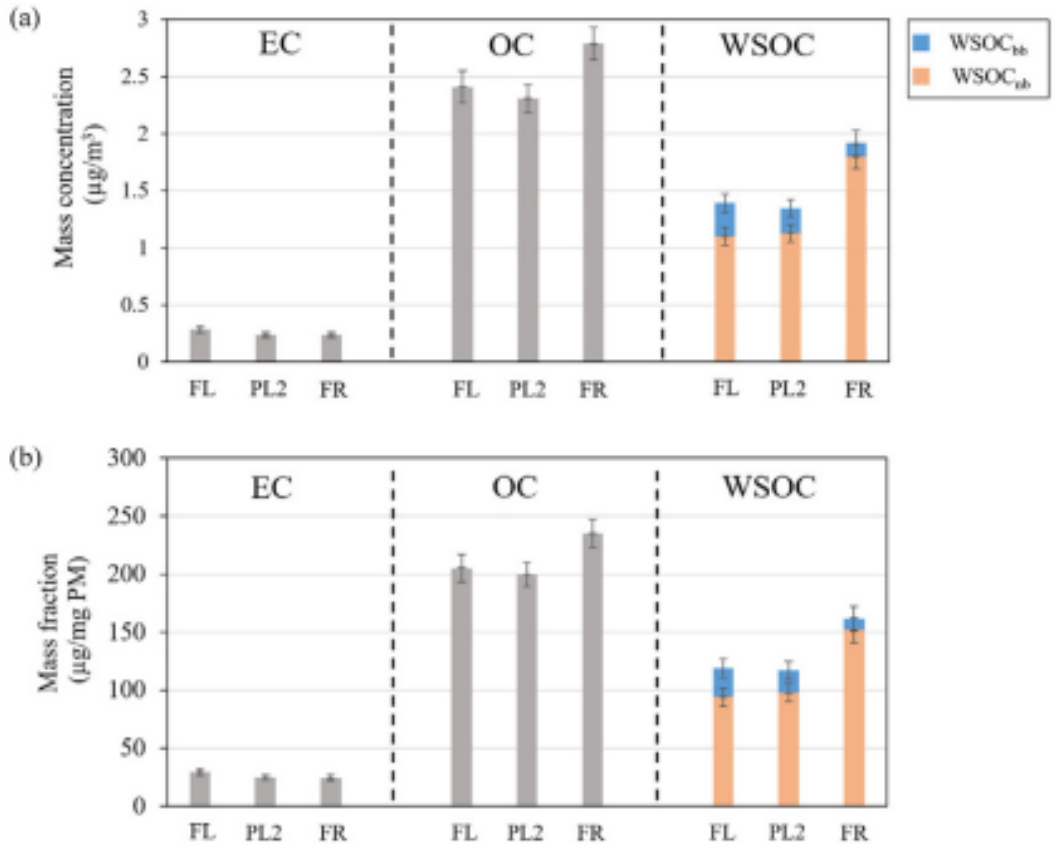

Fig. 6. The elemental carbon (EC), organic carbon (OC), and water-soluble organic carbon (WSOC) fractions of $PM_{2.5}$ during full-lockdown (FL), second partial-lockdown (PL2), and full-relaxation (FR) periods: (a) normalized by the air volume; and (b) normalized by $PM_{2.5}$ mass.

Source: A. Altuwayjiri, E. Soleimanian, S. Moroni, *et al.*, *The impact of stay-home policies during Coronavirus-19 pandemic on the chemical and toxicological characteristics of ambient PM2.5 in the metropolitan area of Milan, Italy*, Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2020.143582

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MAIN FINDINGS

4. **Increasing trend in mass concentration of surrogates of tailpipe emissions** (e.g., traffic-associated **PAHs**) as well as **re-suspended road dust** (e.g., **Fe, Mn, Cu, Cr, and Ti**) **was observed from FL** (full-lockdown) **to PL2** (second partial-lockdown) and **FR** (full-relaxation with limited restrictions) **phases due to the gradual lifting of lockdown restrictions.** On the contrary, **Levoglucosan, as tracer of biomass burning, decreased.**

Covid Lockdown impacts or other pollutants

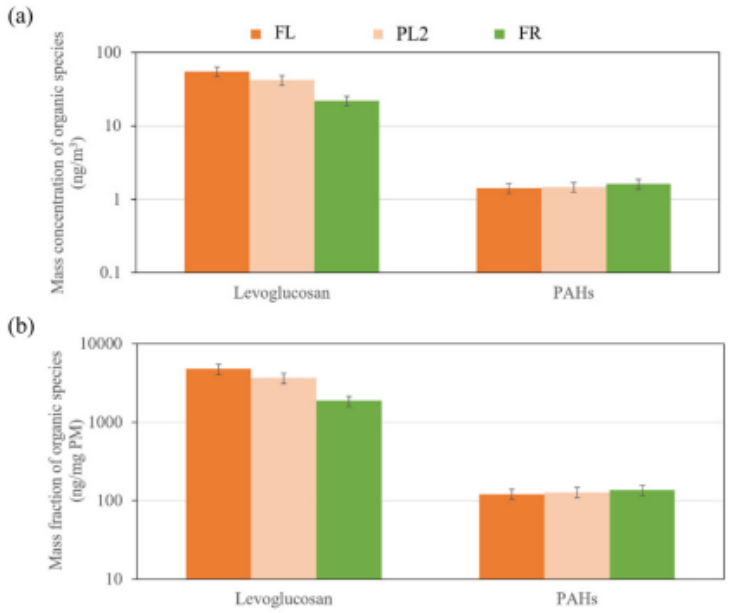

Fig. 7. Temporal trends in levoglucosan and total PAHs concentrations during COVID-19 period normalized by (a) air volume; and (b) $PM_{2.5}$ mass content. FL, PL2, and FR refer to full-lockdown, second partial-lockdown, and full-relaxation periods, respectively.

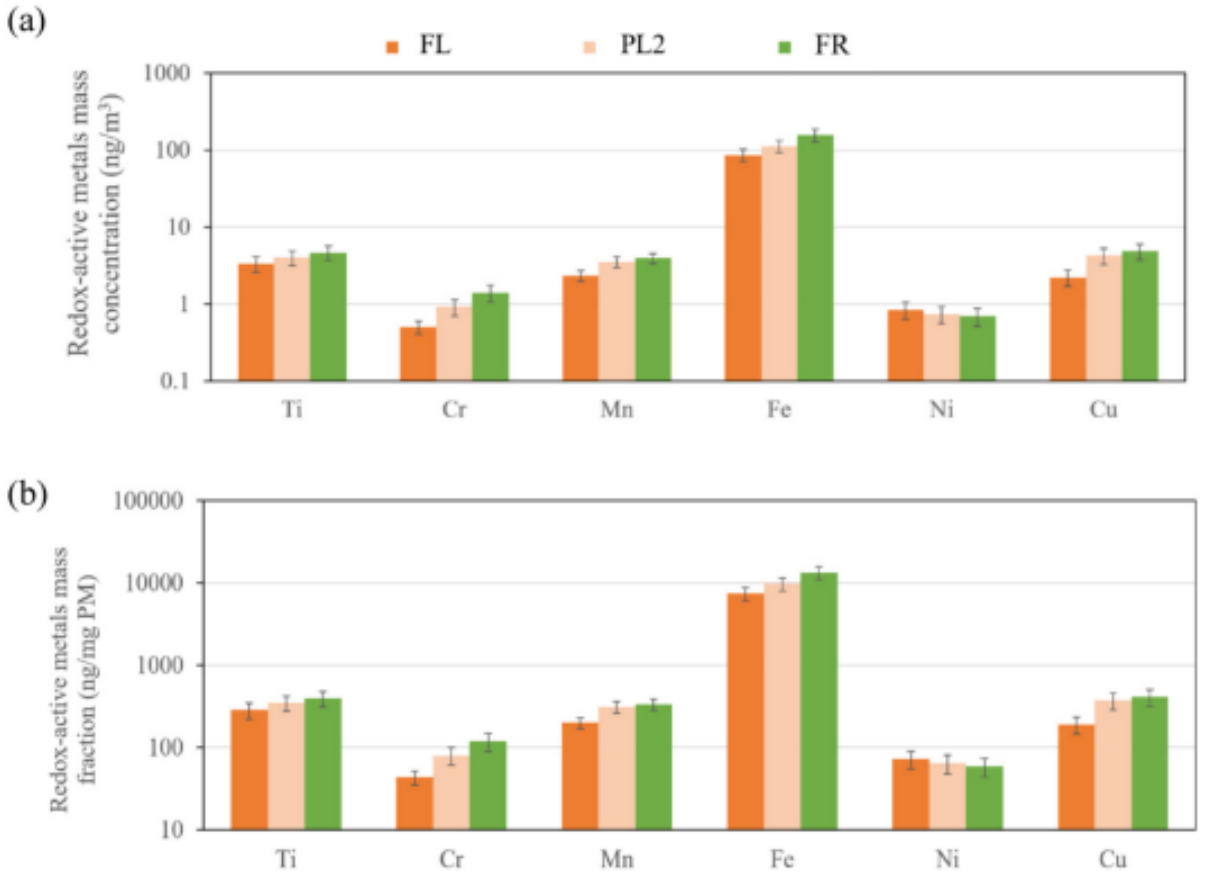

Fig. 8. $PM_{2.5}$-bound redox-active metals concentrations measured during full-lockdown (FL), second partial-lockdown (PL2), and full-relaxation (FR) periods: (a) normalized by the air volume; and (b) normalized by $PM_{2.5}$ mass.

Source: A. Altuwayjiri, E. Soleimanian, S. Moroni, *et al.*, *The impact of stay-home policies during Coronavirus-19 pandemic on the chemical and toxicological characteristics of ambient PM2.5 in the metropolitan area of Milan, Italy*, Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2020.143582

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Covid Lockdown impacts on other pollutants

MAIN FINDINGS

5. The **curtailed road traffic** during **FL** and **PL2** periods led to **~25% drop in the PM2.5 oxidative potential** (measured via 2′,7′- dichlorodihydrofluorescein (DCFH) and dithiothreitol (DTT) assays) with respect to the **FR** period as well as the same time span in 2019.

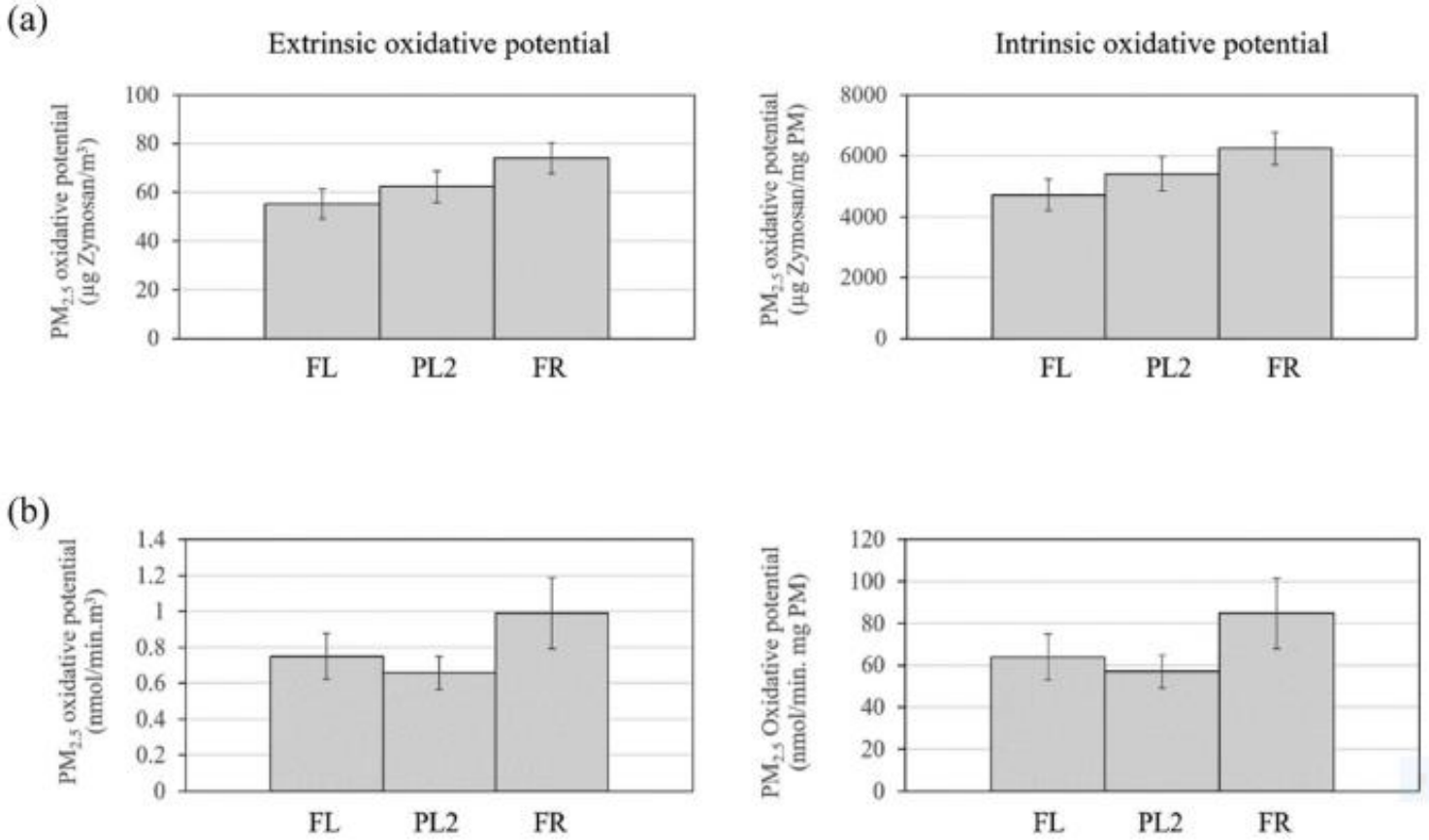

Fig. 9. Air volume-based (extrinsic) and mass-based (intrinsic) oxidative potential of ambient $PM_{2.5}$ during the investigation period measured by the means of (a) DCFH macrophage; and (b) DTT assay (FL: full-lockdown; PL2: second partial-lockdown; FR: full-relaxation).

Source: A. Altuwayjiri, E. Soleimanian, S. Moroni, *et al.*, *The impact of stay-home policies during Coronavirus-19 pandemic on the chemical and toxicological characteristics of ambient PM2.5 in the metropolitan area of Milan, Italy*, Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2020.143582

Milano, May 6th, 2022

Thank you for your attention!

silvia.moroni@amat-mi.it

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AGENZIA MOBILITÀ AMBIENTE TERRITORIO