With the contribution
of the LIFE Programme
of the European Union
LIFE 15 IPE IT 013

prepAIR
Po Regions Engaged to Policies of Air

Covid-19 and air quality in the Po Valley

Short summary - First Quarter 2020

With the contribution
of the LIFE Programme
of the European Union
LIFE 15 IPE IT 013

prepAIR
Po Regions Engaged to Policies of Air

This document is the summary of:

REPORT COVID-19 – PRELIMINARY STUDY OF THE EFFECTS OF COVID-19 MEASURES ON ATMOSPHERIC EMISSIONS AND AIR QUALITY IN THE PO VALLEY – JUNE 2020

Authors and coordinators:

Emilia-Romagna Region
Marco Deserti, Katia Raffaelli, Lucia Ramponi, Carmen Carbonara,

ARPA Emilia-Romagna
Chiara Agostini, Roberta Amorati, Barbara Arvani, Giulia Giovannini, Simona Maccaferri, Vanes Poluzzi, Michele Stortini, Arianna Trentini, Simonetta Tugnoli, Matteo Vasconi

With the contribution of the following authors:

ARPA Valle d'Aosta
Giordano Pession, Claudia Tarricone, Ivan Tombolato

ARPA Friuli Venezia-Giulia
Giovanni Bonafè, Francesco Montanari, Alessia Movia, Alessandra Petrini

APPA Trento
Selene Cattani, Gabriele Tonidandel

ARPA Veneto
Ketty Lorenzet, Silvia Pillon, Laura Susanetti

ARPA Piemonte
Stefano Bande, Francesca Bissardella, Monica Clemente

ARPA Lombardia
Elisabetta Angelino, Giuseppe Fossati, Guido Lanzani, Alessandro Marongiu, Alessandra Pantaleo

Emilia-Romagna Region
Matteo Balboni

This summary has been realized by ART-ER responsible for the communication of the LIFE Prepair project

Graphic and translation assistance
SCS Azioninnova S.p.A. – Demetra Formazione

Table of contents

Index of figures

Index of tables

1 The context

In the first month of 2020, the health crisis caused by COVID-19 pandemic and the consequent containment measures adopted generated a drastic and sudden reduction in some of the main sources of atmospheric pollution. The conditions have therefore been created to be able to test some actions to contrast air pollution in one of the most complex areas of Europe, that is Po Basin, which unfortunately is also among the areas most dramatically affected by health emergency.

For these reasons, the PREPAIR project Steering Committee, consisting of the Po Basin Regions and Autonomous Provinces, the cities of Bologna, Milan and Turin, the Environmental Agency of the Po Basin and of the Slovenian State, ART-ER and FLA, has decided to realize an ad hoc study to evaluate the effect of containment measures on air quality.

It has been planned to conduct the analysis in three consecutive phases:

- First evaluations with the data referred to the period February-March 2020
- Extension of the analysis to the next period and refinement of the evaluations
- Scenario simulation with lockdown emissions

This document is the short summary of the Covid-19 Report – preliminary study of the effect of Covid-19 measures on the emissions into the atmosphere and into the Po Valley air quality, referred to the months of February and March 2020, which aims to provide some initial evaluations on the effects of the containment measures adopted in Italy and in the Po Valley, in order to analyze strategies to contrast air pollution and to better understand the dynamic and complexity of the phenomenon itself.

2 The lockdown measures

Starting from February 24th, with the entry into force of the Law Decree (DL) February 23th 2020 n.6, and the Decree of the President of the Council of the Ministers (DPCM), officially begin the emergency measures to contain the COVID-19 virus diffusion, with the establishment of two “red zones”, corresponding to the first illness sites in Codogno and Vo’ Euganeo, and, at the same time, with the closing of the schools in Lombardy, Emilia-Romagna and in Veneto.

The Table 1 shows the chronology of the main containment measures from February 24th to the end of March.

24 February	**DL 23 February 2020 n 6** **DCPM 23 February 2020**	Establishment of the "**Red Zone**" for the Municipalities, sites of the outbreak, in Lombardy and Veneto (Codogno, Vo’ Euganeo) Closing of schools and universities in Lombardy, Emilia-Romagna and Veneto
26 February	**DCPM 25 February 2020**	Suspension of sporting events, educational trips and other limitations on the whole national territory
2 March	**DPGR Piemonte n. 24 1 March 2020**	Closing of schools in Piedmont.
8 March	**DCPM 8 March 2020**	Establishment of the "**Red Zones**" of Lombardy, Veneto and the Provinces of Modena, Parma, Piacenza, Reggio Emilia, Rimini, Pesaro and Urbino, Alessandria, Asti, Novara, Verbano-Cusio-Ossola, Vercelli, Padua, Treviso and Venice. National closing of pubs, dance schools, game and betting rooms, discos and more, restrictions regarding access to residential structures for the elderly (RSA)
10 March	**DCPM 9 March 2020**	Italy Red Zone Extension of all measures of the DCPM 8 March to the national territory:

		Prohibition of assembly on the whole national territory.
12 March	**DCPM 11 March 2020**	Closing of retail stores with the exception of basic necessities (Food, Pharmacies and others)
23 March	**DCPM 22 March 2020**	Lockdown Closing of non-essential or strategic production activities.

Table 1 –Chronology of the containment measures

3 Impact of the lockdown on polluting emissions in atmosphere

The restriction measures just described have had an impact on the most of the human activity sectors which are responsible of the pollutant emissions: a differentiated impact depending on the sector and growing as more tightly restrictions have been handed down.

The data emissions are estimated starting from the statistics on the activity that emit pollutants, as for example the traffic data or fuel consumption for the heating. As far as possible, we have tried to make evaluations for each sector with homogeneous methodologies.

In the picture 1 and 2 the estimated variations of NO_x and PM_{10} on the entire Po Basin and on individual regions are shown.

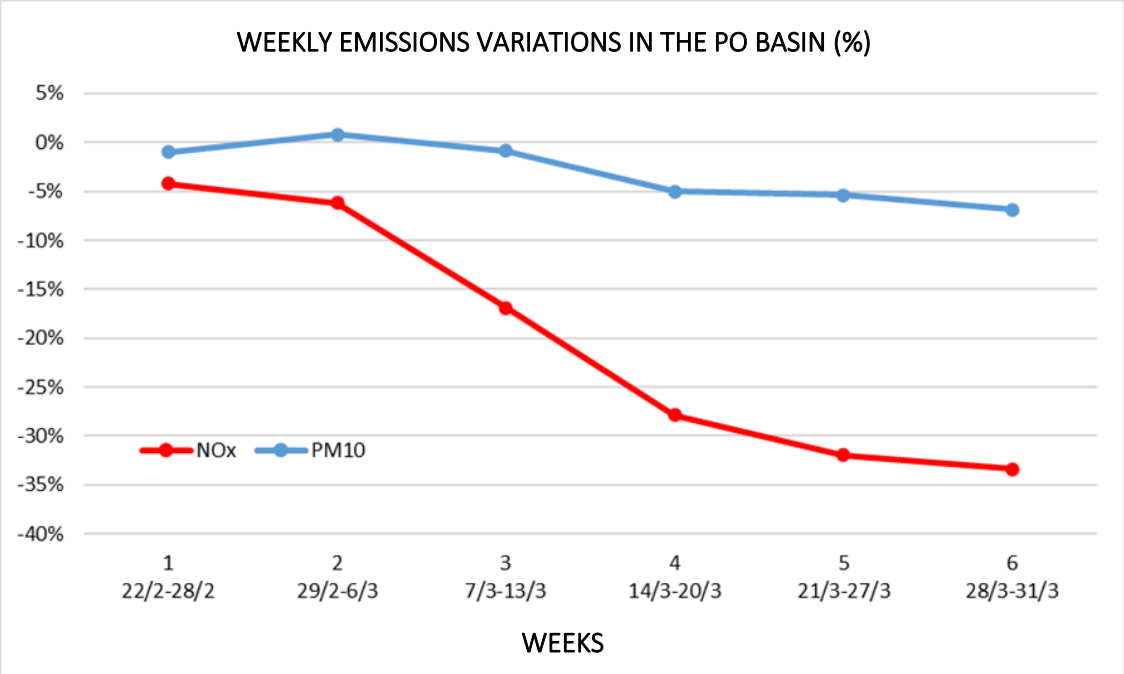

Figure 1 - Percentage emission reductions of NOx and PM10 in the Po Valley

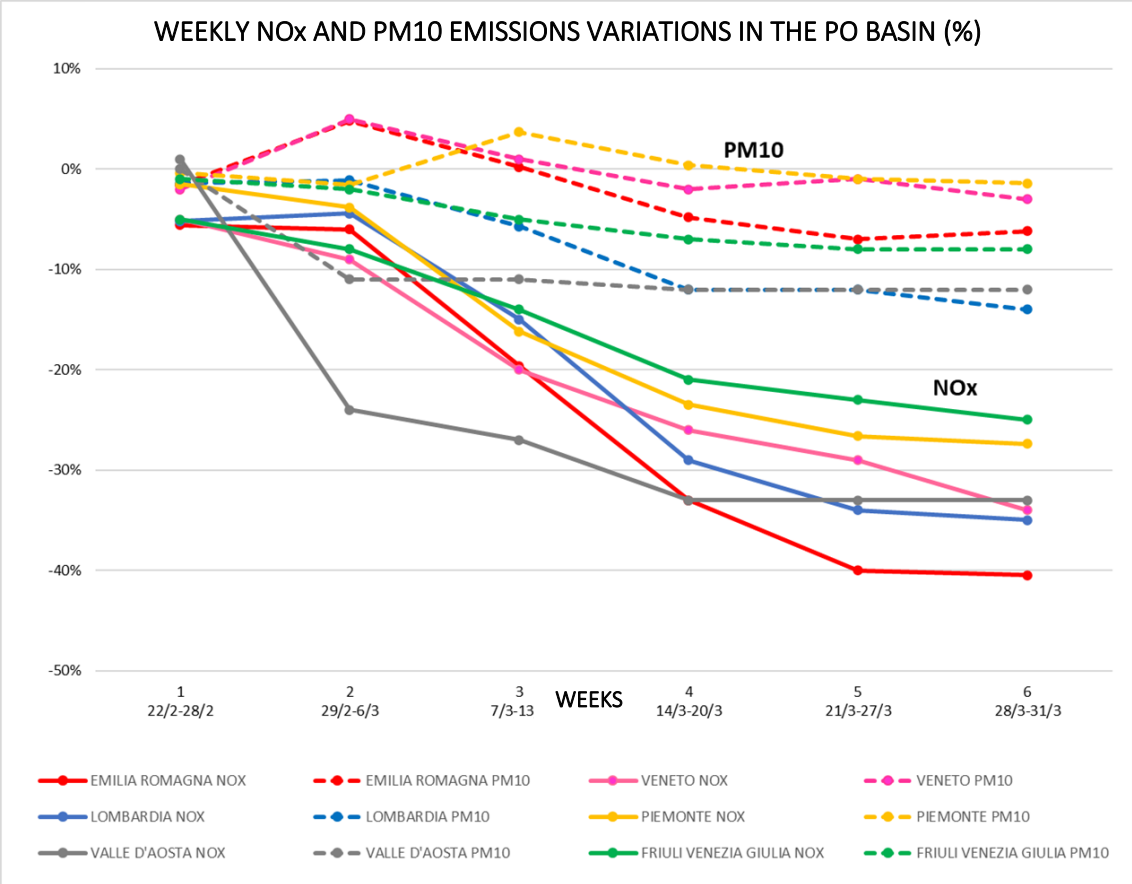

Figure 2 - Weekly emission changes of NOx and PM10 in the project Regions

As can be clearly seen from the graphics, the NO_x emissions are progressively decreased in all territories as the restrictive measures entered into force, reaching an average reduction of almost 35% in all the Po Basin, while the PM_{10} direct emissions have decreased to an average reduction of 7%.

4 Meteorological analysis

The meteorological component is a fundamental element for understanding the dynamics of air quality. Elements such as wind and rain can affect the dispersion of pollutants. On the contrary, days with low wind contribute to the accumulation of pollutants and the consequent deterioration of air quality.

Meteorological variables are an element of criticality for the air quality in the Po Valley that tends to have unfavorable weather conditions to the dispersion, because of the morphological characteristics of the basin: closed to the north, west and south by the Alps and the Apennines, and opened only to the East on the Adriatic Sea, in turn closed by the Balkans.

In the meteorological analysis conducted by the Prepair working group 3 indicators were considered:

- **Stagnation:** detects very weak wind days. If high it creates ideal conditions for the concentration of pollutants;
- **Recirculation**: identifies the wind regimes that keep pollutants in a circumscribed area, also in this case a favourable condition to accumulation;;
- **Ventilation**: is an indicator of the ability to dilute pollutants and encourage their dispersion.

The analysis of these indicators makes it possible to identify favourable days to dispersion and favourable days to accumulation. In addition, at the end of March the Po Valley was the scene of a natural event of transport of a large amount of exogenous dust from the East.

As can be seen from Table 4, the month of March 2020 has been characterized as a whole by meteorological conditions not particularly favourable to the dispersion of pollutants: complexively only 10 days are favourable or very favourable to dispersion.

	DAYS	Weather conditions
MARCH	2-4	favourable conditions for dispersion
	5-6	stability, storage conditions
	7-8	good mixing, dispertion
	9-12	stability, storage conditions
	13-14	advection from the east
	15-22	stability, storage conditions
	23-27	very favourable conditions for dispersion
	28-31	transport of dusts from the east

Table 2 – Weather conditions of March 2020

5 The air quality analysis

The analysis of air quality data in the Po Basin was conducted on 5 pollutants: NO_2, NO, PM_{10}, $PM_{2.5}$ and benzene plus ammonia (NH_3) where the data were available for analysis. The data were collected throughout the Po Basin using the air quality monitoring stations of the network of Prepair partners.

5.1 Boxplot graphics

Boxplots graphics synthetically show the distribution of a set of data. Figure 5 shows the comparison of the daily average of March 2020 and the-years 2016-2019 regarding the concentrations of the pollutants under study.

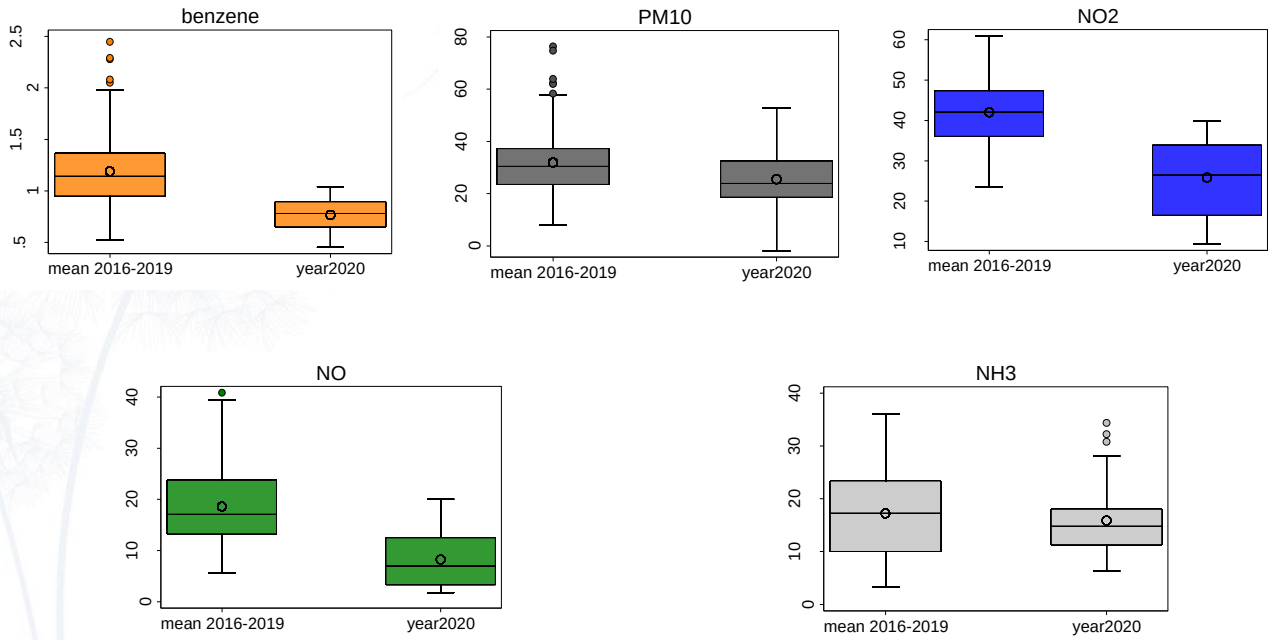

Figure 3 – Comparison of the benzene daily average, PM_{10}, NO_2, NO e NH_3 in the month of March 2020 and in 2016-2019

Based on the above diagrams it is possible to make some considerations:

- The average values for benzene and nitrogen (NO, NO_2) decreased significantly over the period considered when compared with the control data.
- The average distribution of PM_{10} has not undergone such marked variations. There is a drop in values with higher concentrations (the isolated dots at the top of diagrams), indicating less concentrated distribution on high values.
- The average concentrations of ammonia (NH_3) found in Emilia-Romagna (2 stations) Piedmont (2 stations) and Lombardy (10 stations) in the months of March 2020 are substantially the same as in 2016-2019.

5.2 Time series

Figure 4 and 5 show the daily trend of the average concentration of some pollutants measured by all traffic stations in the Po Basin. The black line represents the Basin average in the quarter January-March 2020, the red line represents the average of the period 2016-2019. The punched blue lines represent the maximum and minimum values recorded in the four-year period respectively (average of all maximum and average of all minimum).

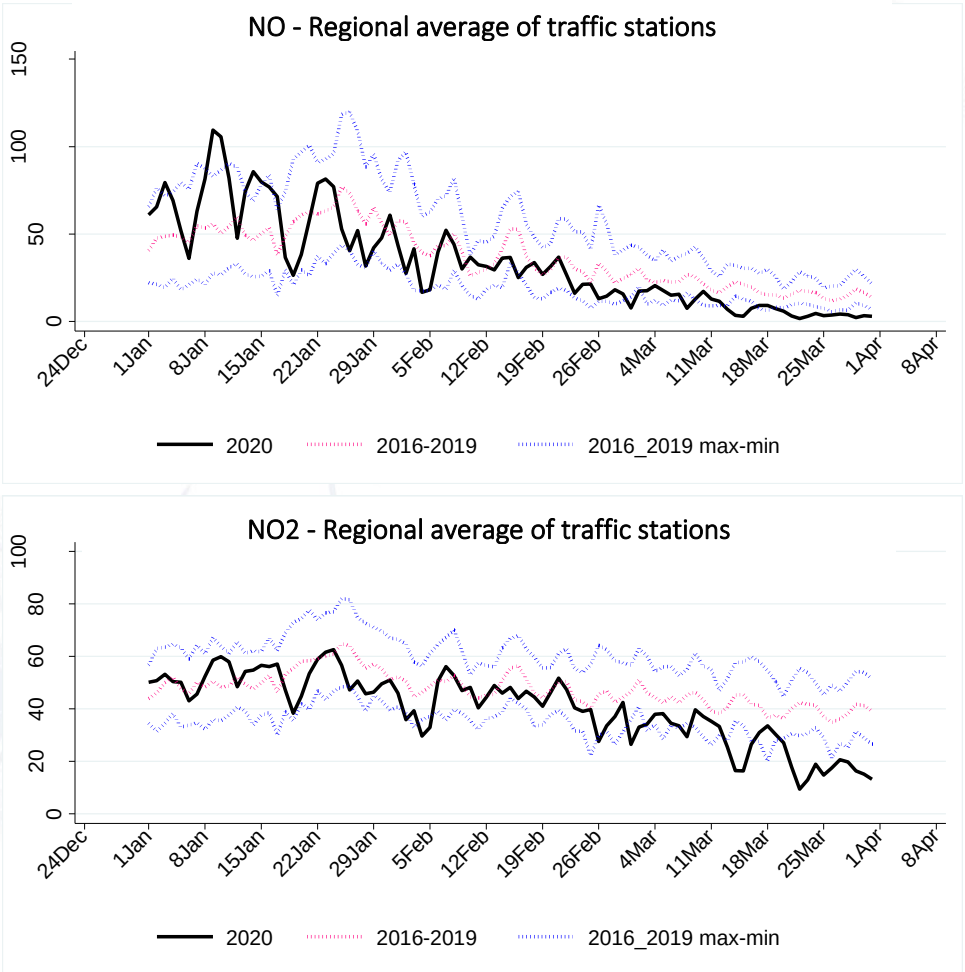

Figure 4 – Trend of regional average traffic stations for NO2 and NO: comparison between Q1 2020 and average 2016-2019

The time series of pollutants gradually decreases in the quarter. The decrease is particularly evident during the month of March 2020. The comparison with the previous average period shows that gas concentrations (even benzene not represented here) are much lower than average and close to minimum values.

The time series of the PM10 is more difficult to read (Figure 5 below):

- We see a sharp drop at the end of February, when it was observed an important reshuffling of air masses lasted a few days, and then, for most of March it keeps values lower than the average 2016-2019 but shows a less noticeable decrease.
- Periods with higher PM_{10} values are often related to stagnation and reduced recirculation periods and coincide with high PM2.5 values. The behaviour of these two pollutants is in fact very similar, especially in the cold season, when PM10 is mainly composed of PM2.5.
- An important peak of PM10, in which the PM2.5 contribution is limited, is the one at the end of March linked to the transport of desert dust from the Caspian Sea, mainly characterized by coarse grain size.
- During the period under review there were episodes of exceedance of the daily limit value of PM_{10} (50 mg/m^3) in two different periods, both characterized by weather favourable to accumulation: between 9 and 13 and between 18 and 21 March.

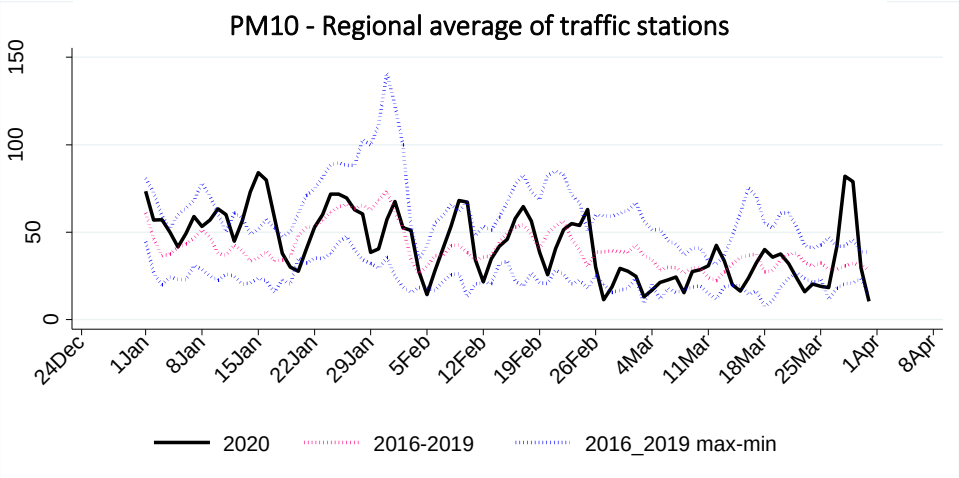

Figure 5 - Trend of regional average traffic stations per PM10 comparison between 1st quarter 2020 and 2016-2019 average

The evolution of ammonia (NH_3) concentrations is not substantially influenced by lockdown. This is because, as said, ammonia derives substantially from the agricultural and livestock sectors which have not been directly affected by the containment measures.

5.3 The estimate impact of lockdown on air quality

To estimate the actual impact of containment measures on air quality, it is not sufficient to compare the measures recorded by monitoring stations in the first months of 2020 with those recorded in previous years.

In fact, a spring 2020 without *lockdown* would certainly not have recorded the same concentrations of 2019 nor previous years, nor even the same of the first months of 2020, given that meteorology - crucial factor for air quality - changes from year to year and with the seasons.

To obtain a reliable estimate of the *lockdown* effect, it is necessary to compare the actual scenario, given by the measures recorded by the air quality monitoring stations, with a hypothetical scenario "NO-LOCKDOWN" that is, with the situation that would have occurred in the absence of restrictive measures.

The "NO-LOCKDOWN" scenario of the Prepair project was reconstructed with two chemical and transport models: NIN-FA-ER and FARM-PI, simulating air quality throughout Northern Italy in first months of 2020 using the real meteorology of 2020 and the expected emissions in a "normal" year, that is without *lockdown*.

The simulation of the first two months of the year, before the adoption of the restrictive measures, allows to calibrate the models adjusting them to the data observed by the control units. After this calibration phase, the two scenarios begin to diverge, and the difference can be attributed only to the emission reductions determined by the *lockdown*

Figure 6 represents the percentage reductions in the actual scenario compared to the hypothetical scenario "NO-LOCKDOWN":

- for NO_2 nitrogen dioxide, at the end of March the reductions arrive at median values on the Po Basin of approximately 35-50%;
- for PM_{10} the reductions are smaller, more differentiated by geographical area, more variable in the several weeks, but reach a median reduction of 15-30%.

The method was subjected to a counter-test, applying it to 2018: in a no-lockdown year, the hypothetical scenario should not tend to diverge from the real data. The test had a good result, confirming the reliability and robustness of the method: no trend divergence was observed and the median differences between the two scenarios are from -15% and + 15%.

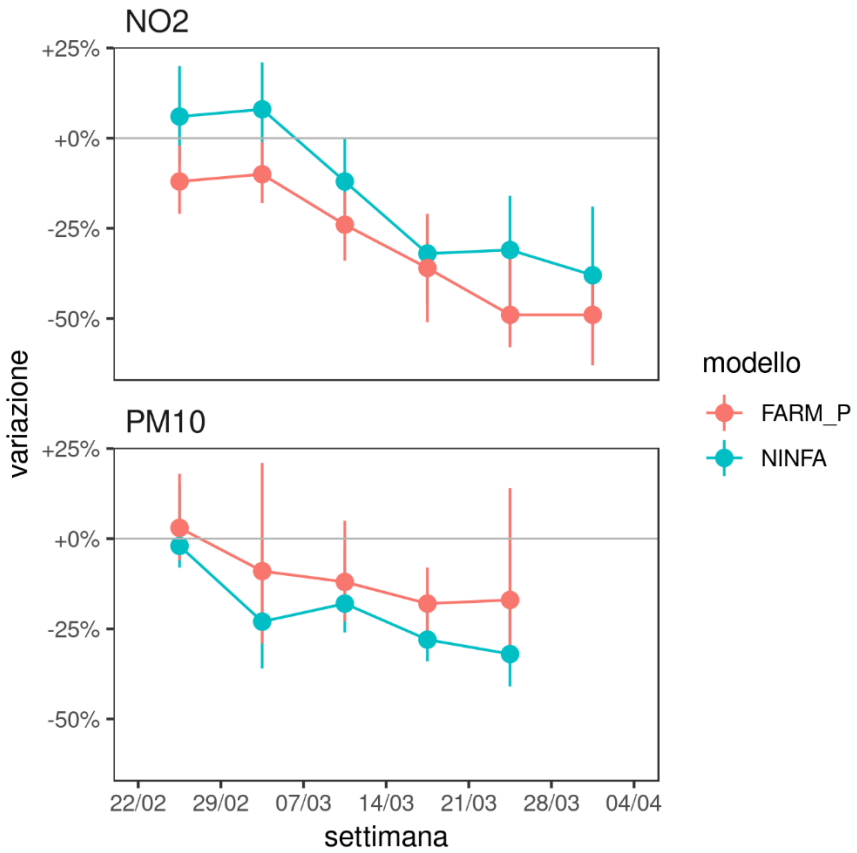

Figure 6 – Percentage reduction between real scenario and "NO-LOCKDOWN" scenario. On the top NO_2, on the bottom PM_{10}. In red the trends related to the FARM_P model, in blue to NINFA

6 CONCLUSIONS

The main problems regarding air quality in the Po basin concern the exceeding of the annual and daily limit value of PM10 and NO2. This determines significant impacts on the health of the population. The improvement of these indicators is the main objective of local, regional and Prepair air quality policies.

In the context of Prepair, it was evaluated that the full application of the measures previewed by the Regional Air Plans and by the Air Quality Agreements, would permit the respect of the limits in most of the Po Valley, significantly reducing the exposure of the population. The emission reductions associated with the scenario of the Plans and Prepair's measures are of the order of 40% for PM10 and NOx and 20% for ammonia (NH3).

The results of the tests on the *lockdown* period are an unrepeatable opportunity to verify the validity of these preconditions and compare them with the data of reduction of emissions and concentrations in an unprecedented condition of generalized contraction of human activities.

Regarding the emission data of March 2020, the following considerations can be deduced:

- NOx emissions had a decrease comparable to that previewed in the plans, with a weekly maximum of 40% and similar trends in the various regions;
- PM10 (primary) emissions had a weekly maximum decrease about 14%, significantly lower than that foreseen by the plans, with diverse trends in the various regions;
- As expected, ammonia emissions haven't been reduced, as agricultural / livestock activities didn't change during the *lockdown*. Small variations are due to traffic (catalytic mufflers).

Regarding pollutant concentrations and therefore regarding the quality of the air we breathe, coherently with the emissions framework, in March 2020 gases (NO, NO_2 and benzene) had significantly decreased compared to the average period 2016-2019.

The concentration of particulates, on the other hand, shows a less important and fluctuating decrease. Although registering a reduction, the PM10 remains within the variability of the previous years (2016-2019), with a temporal trend that doesn't follow the trend of the gases, while it is coherent with the PM2.5 fraction.

Both these data highlight, once again, the complex dynamics of the Particulate and of the relationships between primary emissions, emissions of precursors (such as NOx and NH3) and the climatic conditions that determine both transport and dispersion of dusts, both photochemical processes which transform the precursors in secondary particulates (which is about the 70% of the total particulates).

this dynamic even with low emissions is strongly influenced by unfavourable weather conditions, that can lead to an increase in concentrations of particulate matter up to exceeding the daily limit values although of much lower intensity than in normal conditions.

Currently some possible causes can be hypothesized of the lower reduction of the particulates compared to the gaseous component, but information related to particulate chemistry is needed to verify these hypotheses:

- Emissions of primary PM10 have not been sufficiently reduced, due in particular to emissions from space heating;
- Some precursors, mainly (NH3) have not decreased. The mixture of precursor gases may have remained such that a high secondary production potential is maintained even with varying proportions (less NOX, NH3 constant);
- The high insolation in March increased the production of secondary PM of photochemical origin.

In the next study phases, which will cover the periods following the first quarter of 2020, these hypotheses will be verified also on the basis of the data deriving from the chemical analyzes foreseen in the Prepair project, which will allow to understand if and how the particulate's composition, especially the secondary, is changed.

These first results seem to confirm the effectiveness of the strategy of the Po Basin Regional Air Plans, focused on large-scale multi-sector and multi-pollutant interventions. In particular, they show that reductions in NOx emissions of the order of 40% seem sufficient to achieve the European objectives on nitrogen oxides, while a reduction of PM10 primary emissions in the order of 14% may not be sufficient in the stagnation weather conditions, typical of the Po valley, to ensure compliance with the limit value. There is also a need to act on emissions of precursors such as ammonia, mainly produced by agricultural and animal husbandry activities.

THE PREPAIR PROJECT

The Po Basin represents a critical area for the quality of air, as the limit values of fine powders, nitrogen oxides and ozone set by the European Union are often exceeded. The northern Italian regions re included in this area as well as the metropolitan cities of Milan, Bologna and Turin.This area is densely populated and highly industrialized. Tonsof nitrogen oxides, powders and ammonia are emitted annually into the atmosphere from a wide variety of polluting sources, mainly related to traffic, domestic heating, industry, energy production and agriculture. Ammonia, mainly emitted by agricultural and zootechnical activities, contributes substantially to the formation of secondary powders, which constitute a very significant fraction of total powders in the atmosphere.Because of the weather conditions and the morphological characteristics of the basin, which prevent the mixing of the atmosphere, the background concentrations of the particulate, in the winter period, are often high.In order to improve the quality of the air in the Po Valley, since 2005 Regions have signed Program Agreements identifying coordinated and homogeneous actions to limit emissions deriving from the most emissive activities.The PREPAIR project aims at implementing the measures foreseen by the regional plans and by the 2013 Po Basin Agreement on a wider scale, strengthening the sustainability and durability of the results: in fact, the project involves not only theregions of the Po valley and its main cities, but also Slovenia, for its territorial contiguity along the northern Adriatic basin and for its similar characteristics at an emissive and meteoclimatic level.The project actions concern the most emissive sectors: agriculture, combustion of biomass for domestic use, transport of goods and people, energy consumption and the development of common tools for monitoring the emissions and for the assessment of air quality over the whole project area.

DURATION

From February 1st2017 to January 31 2024.

TOTAL BUDGET

17 million euros available to invest in 7 years: 10 million of which coming from the European Life Program.

COMPLEMENTARY FUNDS

PREPAIR is an integrated project: over 850 million euros coming from structural funds and from regional and national resources of all partners for complementary actions related to air quality.

PARTNERS

The project involves 17 partners and is coordinated by the Emilia-Romagna Region –General directorate for the territorial and environmental care.

www.lifeprepair.eu – info@lifeprepair.eu

Regione Emilia-Romagna

Regione del Veneto

Regione Lombardia

Regione Piemonte

Regione Autonoma Friuli Venezia Giulia

Provincia Autonoma di Trento

arpae agenzia prevenzione ambiente energia emilia-romagna

arpav Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto

Arpa Piemonte Agenzia Regionale per la Protezione Ambientale

ARPA Lombardia Agenzia Regionale per la Protezione dell'Ambiente

ARPA Valle d'Aosta

arpa FVG agenzia regionale per la protezione dell'ambiente del friuli venezia giulia

ARSO ENVIRONMENT Slovenian Environment Agency

Comune di Bologna

Comune di Milano

Città di Torino

ART-ER Attrattività Ricerca Territorio

Fondazione Lombardia per l'Ambiente