

## Conference Proceedings

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# Particulate matter in Veneto and Mestre's west bypass impact

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### Abstract

This analysis considers the quality of the air in Veneto and its trend in relation to particulate matter. We analysed the annual averages of PM<sub>10</sub> concentration and examined data from ARPAV monitoring stations, placed in different contexts. After an in-depth study on the trends recorded regionally and in the Venetian area, the impact of the most important arterial road link between the North East and the rest of Italy was taken into account, being the Mestre west bypass which, since 2009, has been flanked by the 'Passante Autostradale di Mestre' motorway, which has helped solve the most serious traffic jam in Italy.

*Keywords: PM10; PM2,5; annual average; exceedences; Venice; tangenziale Ovest; passante autostradale; Mestre; Airport; Marco Polo; Veneto.*

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### 1. Fine particles in Veneto<sup>1</sup>

Suspended particulate matter or particles in the atmosphere (PM<sub>10</sub> and PM<sub>2,5</sub>) are determined by various substances. The anthropic sources of particulate matter are essentially industrial activities, vehicular traffic and heating systems. The concentrations of the particles in the atmosphere are also related, in addition to the quantity emitted, to the climatic factor, demonstrating strong seasonal variability: the greatest concentrations are detected during the winter months, distinguished by atmospheric conditions of poor dispersion of pollutants and by greater emissions due to certain sources. The main standard of reference on the subject of assessing and managing air quality in Italy is Italian Legislative Decree no. 155/2010 (amended by Legislative Decree no. 250/2012), which transposes the directives 2008/50/EC

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and 2004/107/EC. In this paper, the situation of Veneto, a region with almost 5 million inhabitants, located in the North East of Italy, is analysed with regards to PM<sub>10</sub> and PM<sub>2.5</sub>. The figures that have been analysed were collected by the control units of ARPAV (Regional Agency for Environmental Prevention and Protection), located in various areas: 10 in industrial/traffic zones and 19 in background zones. A downward trend was immediately observed up until 2010, with the averages below the limit of 40 µg/m<sup>3</sup> established by Legislative Decree 155/2010 for PM<sub>10</sub>. 2011 saw a worsening of the situation compared to 2010. Two determining factors can be identified in the average trend of PM<sub>10</sub>: the level of emissions and the climatic conditions. Climatic conditions in fact were the reason for the increase recorded in 2011, a year characterised by high pressure and stagnant air winter. In 2011, the only control unit with values below the limit was that of the city of Belluno, which is close to the mountains. This situation experienced a slight improvement in 2012. The most critical aspect linked to pollution from fine particles is that of the number of exceedence days of the 50 µg/m<sup>3</sup> limit over the course of one solar year which, according to Legislative Decree 155/2010, should not exceed 35. The poorly ventilated climate of the plain contributes to the creation of unfavourable situations. The figures of the control units positioned in the centres of the cities show, in fact, a constant exceedence of the limit. As can be seen from the trend, there was a general decline until 2010 and then an increase in 2011. In 2012 there was a decline in the number of exceedence days of the limit although the figures still show critical situations with values well above those provided for by legislation, with the exception of Belluno.

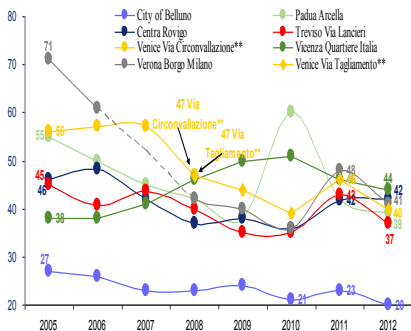


Fig. 1. Annual average of PM10 in some urban and urban traffic control units (µg/m<sup>3</sup>) - Years 2005-2012.

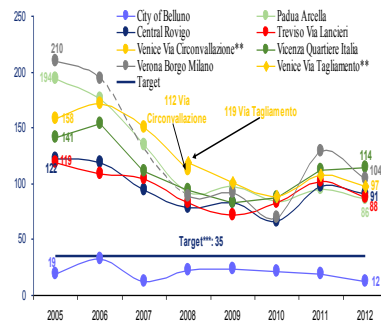


Fig. 2. Number of exceedence days of the daily limit value of PM10 in some urban background and urban traffic control units - Years 2005-2012.

There are also even finer particles, with a diameter below 2.5 micrometers, the so-called PM<sub>2.5</sub>. Legislative Decree 155/2010 establishes a limit for the protection of human health equal to an average annual concentration of 25 µg/m<sup>3</sup> to be achieved before 1st January 2015. An intermediate objective was established for 2012, equal to 27 µg/m<sup>3</sup>. Monitoring the levels of PM<sub>2.5</sub> is not as complete as that for PM<sub>10</sub>, since the detections began later. The figures of the last three years are available for the control units located in urban and suburban background zones. With regards to the urban and suburban areas the trend of the three years 2010, 2011 and 2012 reflects what was also seen for PM<sub>10</sub>: a peak in 2011 which then returned in 2012. With regards instead to the control units located in the industrial areas, only the data of Padua and Monselice are available (2010 and 2011). With regards to the two areas in Padua, the highest values were observed in 2011 and, in any case, values higher than the limit of 27 µg/m<sup>3</sup> were detected throughout the entire three year period considered. However, in

Monselice, the data from the two years available show values a little lower with 21 and 26  $\mu\text{g}/\text{m}^3$  respectively. For the urban traffic zones, data are available from the control units of via Tagliamento in Venice for the years 2010-2011 and central Rovigo for the years 2011-2012.

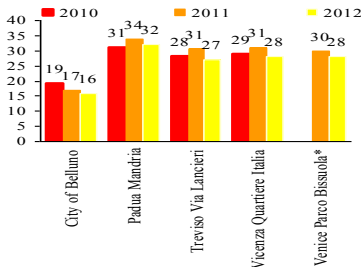


Fig. 3. The average concentrations of PM<sub>2.5</sub> in the urban background and suburban control units ( $\mu\text{g}/\text{m}^3$  annual averages) - Years 2010-2012.

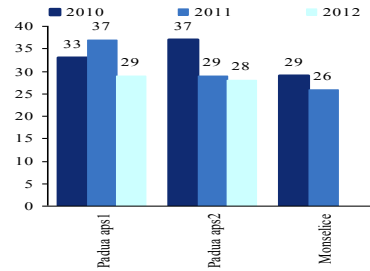


Fig. 4. The average concentrations of PM<sub>2.5</sub> in the urban and suburban industrial background control units ( $\mu\text{g}/\text{m}^3$  annual averages) - Years 2010-2012.

The Veneto Region has joined an interregional convention for monitoring pollutant substance emissions in the air with a software that is an inventory of the atmospheric emissions and is called Air Emissions Inventory (INEMAR). With regards to Veneto, at the moment, the figures from 2005 and 2007 are available. Apart from the criticalities still present, a positive figure emerges: emissions are declining with regards both to PM<sub>10</sub> (-12.5%) and PM<sub>2.5</sub> (-12%). The three main macro sectors, in terms of emissions are: a) non-industrial combustion; b) road transport; c) other mobile sources and machinery.

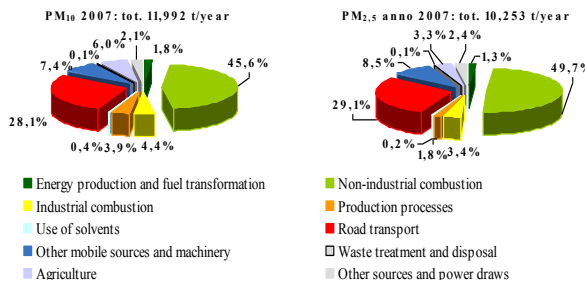


Fig. 5. Emissions of PM<sub>10</sub> and PM<sub>2.5</sub> per macro sector (percentage values). Veneto – Year 2007.

## 2. The Venetian Area<sup>2</sup>

Now we are going to focus on the Municipality of Venice, by analysing all the data of the control units monitoring fine particle concentrations for the years 2003 to 2012. It should be remembered that various provisions have been in force for many years in the municipal territory: ranging from the control of boilers to the prohibition of the circulation of non-catalysed vehicles, to the control of vehicle emissions. Furthermore, measures such as the expansion of pedestrian areas, the institution of 30 km/h zones, the introduction of the tram and the creation of peri-urban woods have also been implemented. As for the rest of the

<sup>2</sup> This paragraph was edited by Lorenzo Mengotti

region, the historical series of annual average concentrations of  $PM_{10}$  in the Municipality of Venice show a tendency to decrease in concentration, until arriving in 2010 at lower values than the annual limit value. Going into more detail on the individual monitoring control units, those located in Malcontenta, in the Bissuola park, in Sacca Fisola and in via Circonvallazione (replaced from 2009 by that on via Tagliamento) are considered. The Malcontenta control unit is located in an industrial/urban background. The figures available only cover the last two years, 2011 and 2012, and they demonstrate quite a serious situation, with over 80 exceedence days over the daily limit of  $PM_{10}$  and an annual average that fell only in the last year and equalled the limit set by legislation. The Bissuola park control unit is in a strictly urban context. Over time there has been a trend to speculate that on a regional scale 2005 to 2007 was a difficult period, followed by a decrease in the subsequent years, a new increase in 2011 and a small decline in 2012. In terms of exceedence days of the daily limit, a difficult situation remains: in the last year 76 have been recorded, however the figure on the annual average is a little more comforting as, since 2008, it has been kept below  $40 \mu\text{g}/\text{m}^3$ . Another control unit located in a background area is that in Sacca Fisola. Here a rather fluctuating average trend was seen between 2004 and 2007. Afterwards there was a three year period with values under the limits, a new peak in 2011 and a decrease in 2012. Also in the case of Sacca Fisola, there were greater problems linked to the number of exceedence days of the daily limit of  $\mu\text{g}/\text{m}^3$ . The last detection point is represented by two control units, i.e. that on via Circonvallazione, decommissioned in 2009, and that on via Tagliamento which replaced it. These two control units are representative of an area of urban traffic. In fact, the values show: the annual averages were always above  $\mu\text{g}/\text{m}^3$  until 2009, even if a downward trend is seen. In 2010, the first value under the target was recorded, to then rebound in 2011, whilst in 2012 the average concentration was exactly  $40 \mu\text{g}/\text{m}^3$ . Looking at the number of exceedence days of the daily threshold, it emerges how the urban traffic zone presents particular criticalities with regards to this phenomenon, recording 118 exceedences on average.

In addition to road traffic, domestic heating and industrial production, the Municipality of Venice has a further potential source of pollution, which is the presence of Marco Polo Airport and, in particular, the air traffic as well as all the activities connected to it, which especially involve the town of Tessera. The company that manages the Airport (SAVE S.p.A.), in collaboration with the Ca' Foscari University in Venice, and the 'Ente Zona Industriale di Porto Marghera' (Porto Marghera Industrial Park Authority), has promoted the project "Monitoring Emissions of Airport Origin" in order to keep the concentrations of some pollutants near to the Airport under control. This is especially important considering that the Airport is located near to the Venice Lagoon, which is simultaneously a complex and very delicate ecosystem. The pollutants controlled include  $PM_{10}$ . From the monitoring carried out, the great influence of the meteorological factor was confirmed and, in particular, the intensity and direction of the wind on the values of fine particles detected. A greater criticality was observed during the winter months, regardless of the lower air traffic. The data monitored by the Airport control unit are compared with those of the control units bordering the Municipality of Venice; in particular, this comparison was carried out with the control units placed in Bissuola Park and via Tagliamento, representative, respectively, of Urban Background (UB) and Urban Traffic (UT) zones. Based on the data collected by the control units in the three year period 2010-2012, it emerges that in the vicinity of the Airport the average concentrations of  $PM_{10}$  remained rather low compared to both at Bissuola park and in via Tagliamento. The same can also be said with regards to the number of annual exceedences of the daily limit of  $50 \mu\text{g}/\text{m}^3$ : even though they were always above the 35 provided for by legislation, they were always below those recorded in the other two control

units of reference. From a more in-depth analysis of the daily trends, similar trends were seen, confirming that the pollution sources are almost the same and that the Airport is one of them, but does not have a more heavy effect than the others. It was also observed that increasing the wind speed decreases the concentration of PM<sub>10</sub> regardless of the direction: this suggests that fine particles are widespread in the territory and the concentrations in the Venetian area are not predominantly influenced by the Airport. In summary, it seems that the Airport, although contributing to the pollution by fine particles, does not give a contribution higher than those of other sources such as vehicle traffic, industrial production and domestic heating.

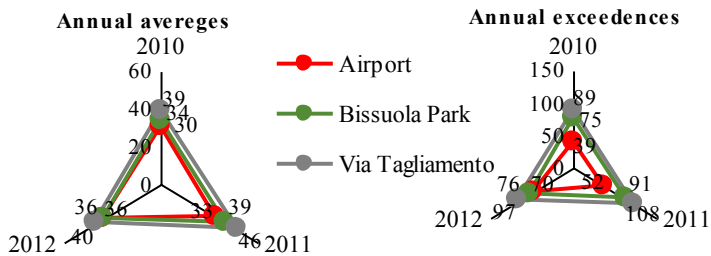


Fig. 6. Annual averages ( $\mu\text{g}/\text{m}^3$ ) and concentration exceedences of PM<sub>10</sub> at the Marco Polo Airport and the control units bordering the Municipality of Venice - Years 2010:2012.

### 3. The Mestre's west bypass and the 'Passante Autostradale' motorways<sup>3</sup>

We now want to place focus on a very critical aspect linked to pollution from PM<sub>10</sub>, the traffic in the main connection route between the North East and the rest of Italy: i.e., the Mestre's west bypass up until 2009 and then the 'Passante Autostradale' motorway (32 km long) which relieved some of the vehicle load. The growing awareness on the topic of health and combating sources of pollution led to the performance of an epidemiologic survey on the effects on the health of the population residing close to the Tangenziale Ovest conducted by the Department of Molecular Medicine – Public Health Laboratory and Population Studies of the University of Padua during the period 2011 – 2012. The aim of the survey was to ascertain the presence of an association between the state of citizens' health resident in the area concerned and the air pollution linked to vehicle traffic flow on the Mestre's west bypass, using the epidemiological tool of the Venetian cohort census, designed by the National Statistical System. The diseases identified mainly regard respiratory and cardiovascular diseases, which are those most affected by exposure to atmospheric pollutants. The identification of the dimensions of the residential area mainly involved and, consequently, of the subset of the population considered exposed, were based on the consequence modelling study of PM<sub>10</sub> concentrations deriving directly from vehicles driving on the Mestre's west bypass in the winter season of 2002, prior to the opening of the third lane. The excess of incidence and prevalence detected in the resident population in the closest area to the Mestre's west bypass for chronic diseases specifically in the cardio respiratory system could be attributed to the pollution produced by the traffic present on the Mestre's west bypass. These results fall within the known dimensions of damage caused by atmospheric pollutants, they are not influenced by socio-economic variables and cannot be attributed to random variations having exceeded the statistical threshold of significance. To better understand the most recent developments, it is recommended to compare the data

<sup>3</sup> This paragraph was edited by Federico Rizzardo

regarding traffic of 2008 with those in 2013, in order to have an initial overview of the changes which occurred following entry into service in 2009 of the 'Passante Autostradale' motorway. To this end, the data of the entries and exits onto the motorway from the 'Padova Est' exit and the 'Venezia-Mestre Ovest' exit are taken into consideration, with regards to the daily averages and then in relation to the annual integer. It was observed how the overall volume of traffic of Padova Est grew by over 8% from 2008 to 2013 and, despite this, the total number of transits for the Venezia-Mestre Ovest motorway decreased by 31% due to the effect of the 'Passante autostradale' motorway, which certainly relieved the traffic on the Mestre's west bypass. In order to determine the framework of the analysis, focus is placed on the 'Passante autostradale' motorway, trying to define its environmental impact regarding  $PM_{10}$ . The monitoring of the air near to the 'Passante autostradale' motorway for the assessment of the impact on the resident population was entrusted to ARPAV during the performance the works and, subsequently after the road was opened to traffic. 16 monitoring campaigns have been performed in 6 different sites positioned in the areas bordering the route of the Passante and with the duration of about 45 days each, using mobile control units. For each site, the monitoring campaigns were carried out during both a cold period and a hot period, in order to also assess the differences connected to the climatic factor which. To better understand the impact of the 'Passante autostradale' motorway, the data monitored in the mobile control units during the detections were compared with those from the fixed control units of the Municipality of Venice located in urban background areas and urban traffic areas. The monitoring campaigns were carried out near to the towns of Mirano-Vetrego, Spinea, Martellago, Mogliano Veneto, Scorzè and Quarto d'Altino, with monitoring stations located to distances between 10 and 1,330 mt from 'Passante autostradale'. In summary, the daily trends of the  $PM_{10}$  concentrations have showed consistency with those recorded in urban background areas and urban traffic areas, characterised by critical situation and therefore to be kept constantly under control.

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