air quality
in Emilia-Romagna

2013 Report Synthesis

arpa
agenzia
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Regione Emilia-Romagna

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Introduction

With this third edition of the Annual Report on Air Quality in Emilia-Romagna, the Region continues the process of reporting and information on the levels of pollutants and on policies put in place for the protection of public health from air pollution.
The measures adopted in the past decade have enabled us to achieve significant results, leading to an improvement in air quality. This is encouraging, but the persistence of exceedances tells us that it is essential to increase the efforts and act synergistically on the processes that generate pollutants through the integration of sectorial policies.
With these targets, in 2012 the Region started off the process of the first Regional Integrated Air Quality Plan (PAIR2020). The key word of the planning process is "integration", believing that in order to comply with the air quality standards set by Europe we need a cross-sectorial approach, as well as coordination between the objectives of reducing greenhouse gas emissions and the recovery of air quality.
In fact, the plan comes to organize a whole series of measures and sectorial programs implemented over the years by the Region. One of the more recent instruments is the tenth Air Quality Agreement, which for the first time has a three years perspective and puts in place a package of structural measures, managerial and emergency actions, with funding for the sustainable mobility of persons and goods, for green infrastructures, upgrading of energy efficiency, as well as information and education activities during the ecological Sundays.
The primary focus of the Plan is the sustainable development of cities, geographical areas which host the main emission sources and where there is the highest density of population exposed to pollutants. The planning is oriented to combat urban sprawl, through peri-urban green belts that pose a physical limit to the use of land, and to develop an urban environment that allows sustainable styles of life and work, guided by a usability of the territory and services with low environmental impact.
This is a complex process that starts from the awareness that the air quality management requires joint and coordinated efforts of all stakeholders, citizens and institutions, from local to national and European level.

Sabrina Freda
Regional Minister for Environment and Urban Regeneration of Emilia-Romagna

Executive summary

What do the data tell us?

The Emilia-Romagna region is located in the south-west part of the Po valley basin, a densely populated and heavily industrialized area, where meteorological conditions, due to the low wind intensity, cause the stagnation of the chemical air mass, associated with peak pollution episodes of PM during the winter and high level of ozone during the summer.
With respect to air quality, the territory of the region is classified into 3 zones (west and east plane areas, and Apennines mountain and hill area) and 1 agglomeration (Bologna area). Air quality assessment is carried out by means of a monitoring network, composed of 47 stations (fig. 13), and modeling techniques.
Air quality data collected in 2012 show that the concentrations of primary pollutants, such as sulfur dioxide, carbon monoxide and benzene, are largely below the limit values, as it has occurred for several years. Most of the pollutants contained in particulate matter, such as heavy metals and some volatile organic compounds (i.e. benzo(a)pyrene), are also under control. Nevertheless some primary pollutants, such as SO_x, VOCs and ammonia, together with NO_x, play an important role as precursors of secondary pollutants, such as PM_{10}, $PM_{2,5}$ and ozone. Due to the large number of sources, nitrogen oxides are widely scattered, as revealed by the analysis of the spatial distribution of the annual mean of NO_2 (fig. 8), with peak concentrations located close to main roads, industrial and urban agglomerates. Only some exceedances of the annual limit value for NO_2 were recorded during the 2012 and 2013 (8 traffic stations in both years), while all the background stations were under the limit value. This confirms the slow but significant decrease of the air concentration of NO_2 within the last five years (fig. 7).
The most critical pollutants are PM_{10}, in winter, and ozone, in summer. It is assessed that in Emilia-Romagna region, during 2012 and 2011 years, more than 60% of the population was exposed to PM_{10} levels exceeding the daily limit value for the protection of human health. During the last decade the daily limit value for PM_{10} was exceeded between 80 and 140 days per year. During 2012, 33 of the 47 stations measuring PM_{10} were over the daily limit value, while the annual limit value was exceeded by only 3 stations. During 2001-2012 period, PM_{10} annual mean shows a slow, but statistically significant, downward trend for most stations. Year 2010 was the first one when, for all the monitoring stations, concentrations below the annual limit value were recorded, while during 2011 and 2012 the annual mean increased again. Such inter annual variability of air quality is strongly related to meteorological conditions, as it is shown by the annual evolution of the number of days favoring the formation of secondary PM_{10} (fig.11). Summer 2012 was the second hottest (after 2003) since 2001 (fig. 12). Such conditions, combined with the availability of precursors of the photochemical processes (NO_x and VOCs), caused a large number of ozone exceedances for both the target value for the protection of human health and the information thresholds. The target value for ozone was exceeded by all stations (fig. 5) and almost over the whole territory (fig. 6).
With regards to $PM_{2,5}$, only few traffic stations exceed the limit value that will be enforced in 2015.
The main sources of precursors of PM and ozone pollution, such as NO_x and VOCs, are related to road transport and combustion (non industrial plus energy and manufacturing industry), while the main source of ammonia, an important precursor of PM pollution, is agriculture (fig. 10). The consumption of diesel fuel for trucking is responsible of a large part (63%) of NO_x emissions, while important sources of PM_{10} emissions derive from wood combustion, motor vehicles exhaust and not exhaust (brake and tire wear, abrasion of roads). An important role is also played by the transport of pollutants from the neighbored regions of the Po valley basin.

WHAT IS HAPPENING?
Air quality

Primary pollutants are no longer a problem

Primary pollutants, such as carbon monoxide and sulfur dioxide, which were in the past the major pollutants of urban and industrial areas, are not currently critical. Also some of the pollutants contained in atmospheric aerosol, such as heavy metals and benzo(a)pyrene, are under control. Monitoring data also show a steady decrease of benzene concentration during the last years. Many primary pollutants, such as nitrogen oxides, volatile organic compounds, ammonia and sulfur dioxide, contribute to the formation of secondary pollutants, even at concentrations below the limit.

Slow downward trend in the annual average concentration of PM_{10}

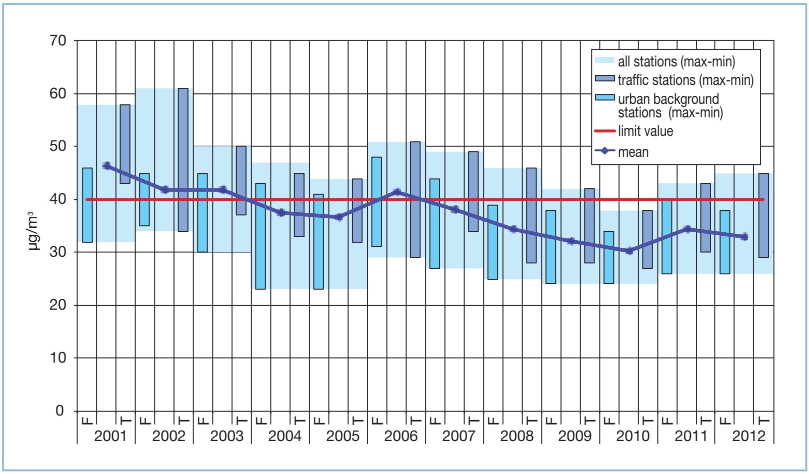
The exceedances of the annual limit value for PM_{10} decreased in the period 2001-2012, with the exception of remote background stations, where the annual average concentration of PM_{10} is constant over time. 2010 was the first year in the historical record when no exceedances of the annual limit value were observed, while in 2011 and 2012 the limit value has been exceeded in few monitoring stations (3 and 4 respectively). The inter annual variability of the PM_{10} concentration is strongly affected by meteorological conditions.

Systematic exceedances of limit imposed by current legislation for PM_{10} and ozone

The most critical situations are related to the exceedance of the PM_{10} daily limit. In the period 2001-2012 the number of exceedances range between 80 and 140 per year (the limit is 35), depending on the stations and years considered. The highest number of exceedances are usually recorded in traffic stations, but also urban background stations often largely exceed the limit value. The minimum number of exceedances was observed in 2009. The number of exceedances increased in 2011 and 2012 especially in the traffic stations. The ozone levels are systematically over the target values for health protection in most part of the Emilia-Romagna region. Higher ozone concentrations were observed in the hotter summers, such as summer 2003 and summer 2012 (respectively the first and the second hottest summers of the time series). Within the past decade, summer 2012 was the summer with the second highest number of days with meteorological conditions favourable to ozone formation.

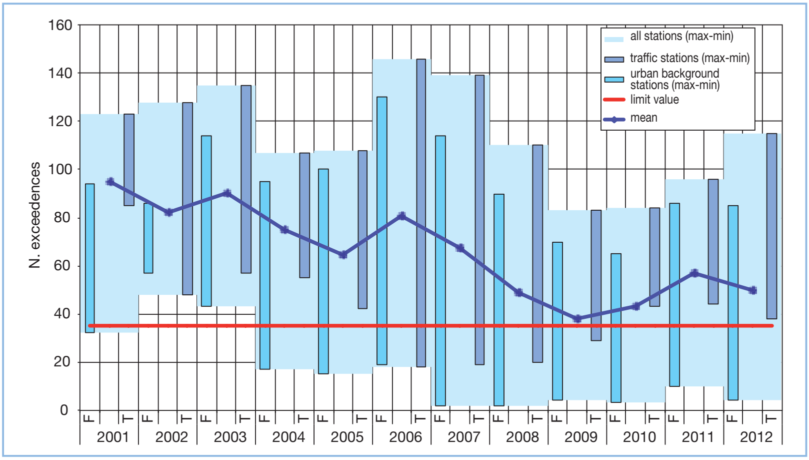
$PM_{2,5}$ and NO_2 concentrations were almost stable in the last years

In 2012 the limit value for $PM_{2,5}$, which will come into force in 2015, was exceeded in a small number of stations. The number of people living in areas where the recorded levels of $PM_{2,5}$ exceed the limit value is small. The spatial distribution of the annual average concentration of $PM_{2,5}$ is quite uniform, due to its prevailing secondary origin. In 2012 the NO_2 limit value for health (annual average) was exceeded only in some traffic stations. The background concentration of NO_2, although below the limits, plays an important role in the atmospheric processes producing ozone and fine particulate matter.



Source: Arpa Emilia-Romagna

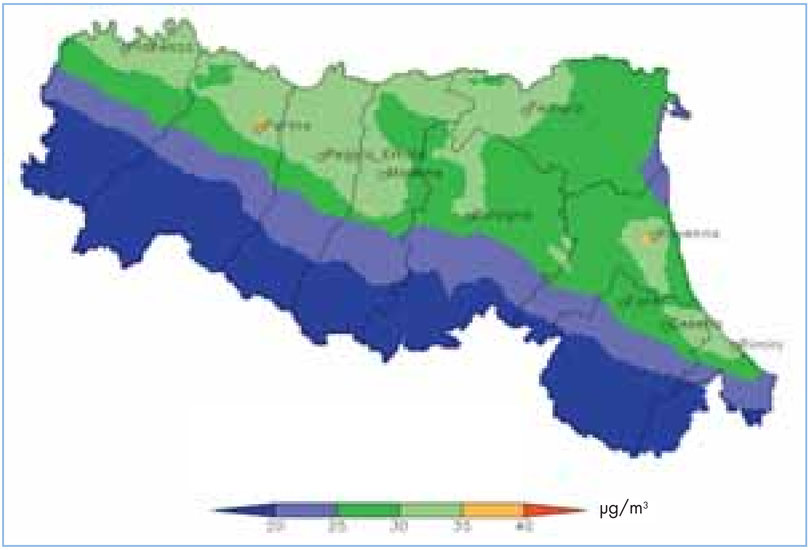
Figure 1: PM_{10} - Annual mean concentration, observed in Emilia-Romagna, per station type (2001-2012)



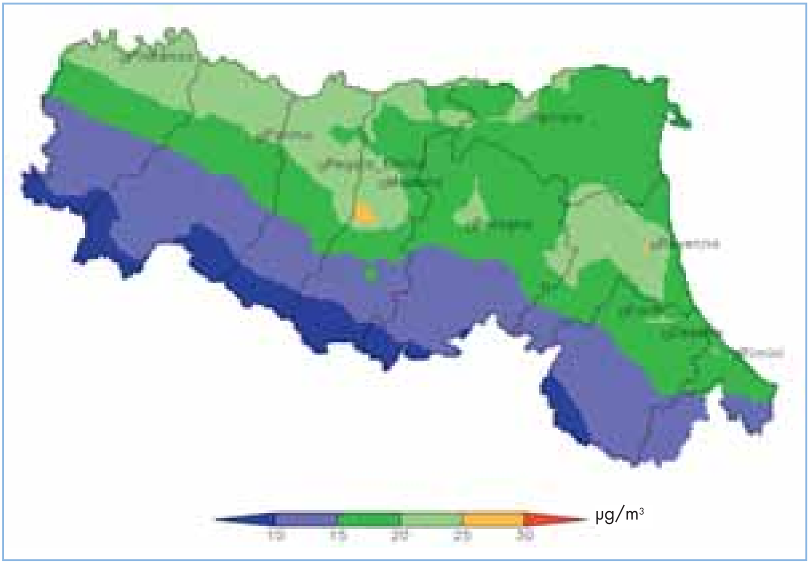
Source: Arpa Emilia-Romagna

Figure 2: PM_{10} - Annual number of exceedances of the daily limit value, observed in Emilia-Romagna, per station type (2001-2012)*

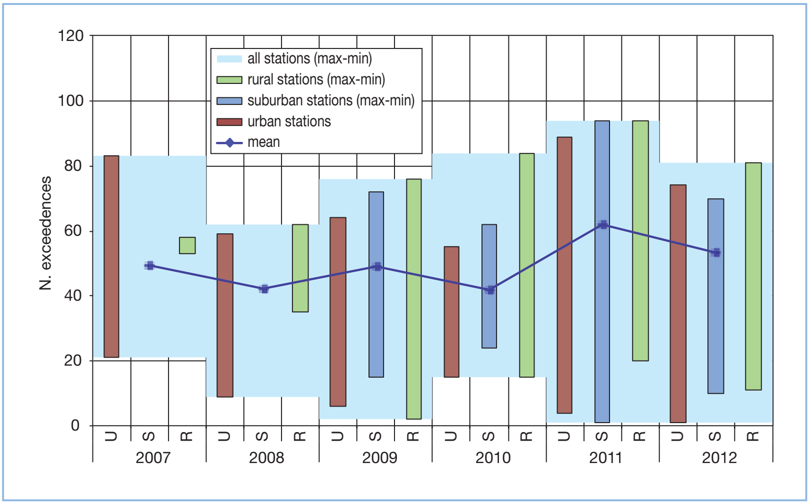
*Note: * 50 μg/m³, daily average, not to be exceeded on more than 35 days per year*



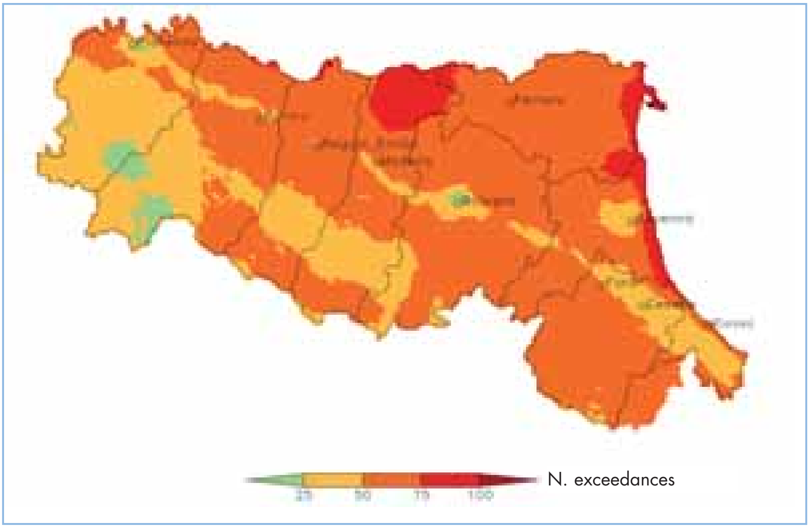
Source: Arpa Emilia-Romagna
Figure 3: Spatial distribution of PM_{10} annual mean background concentration (year 2012)



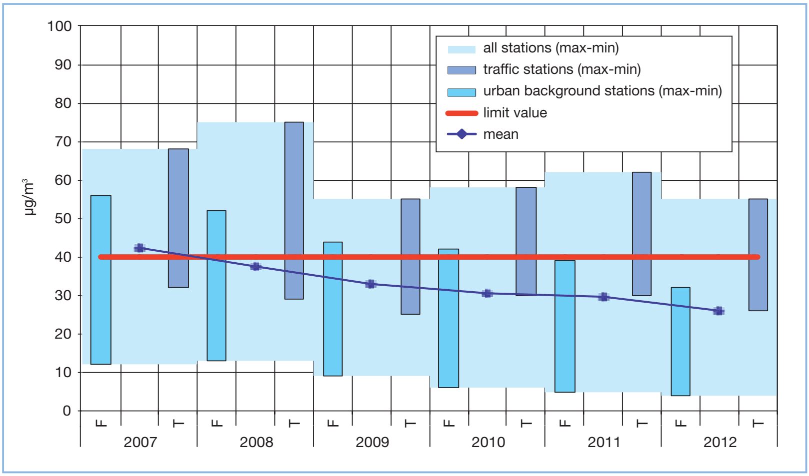
Source: Arpa Emilia-Romagna
Figure 4: Spatial distribution of $PM_{2,5}$ annual mean background concentration (year 2012)



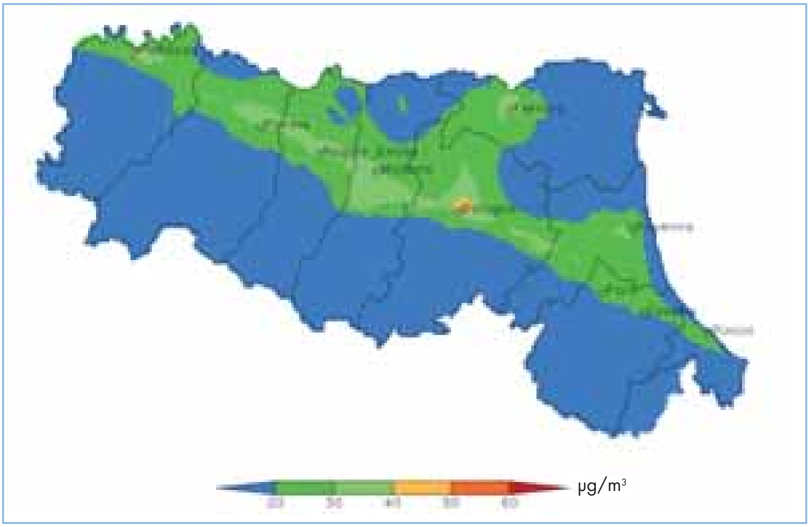
Source: Arpa Emilia-Romagna
Figure 5: O_3 - Annual number of exceedances of the long term objective for human health, observed in Emilia-Romagna, per station type (2007-2012)*
*Note: * 120 µg/m³, daily maximum 8-hour mean*



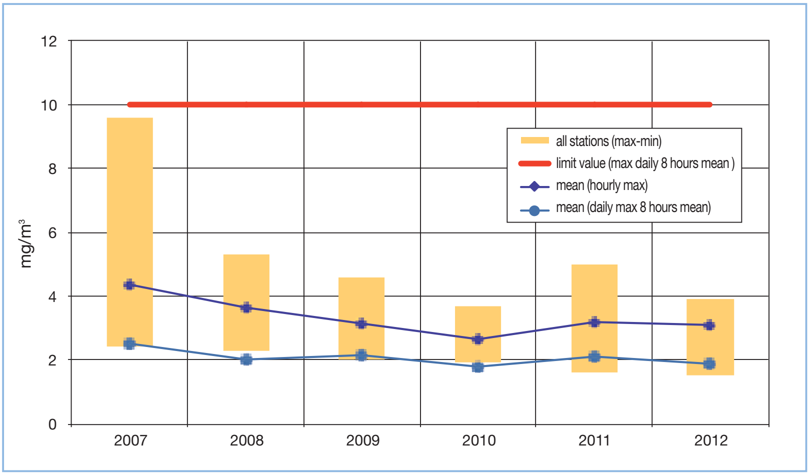
Source: Arpa Emilia-Romagna
Figure 6: Spatial distribution of O_3 annual number of exceedances of the long term objectives for human health (year 2012)*
*Note: * 120 µg/m³, daily maximum 8-hour mean*



Source: Arpa Emilia-Romagna
Figure 7: NO_2 - Annual mean concentrations, observed in Emilia-Romagna, per station type (2007-2012)



Source: Arpa Emilia-Romagna
Figure 8: Spatial distribution of NO_2 annual mean background concentration (year 2012)



Source: Arpa Emilia-Romagna

Figure 9: CO - Average over Emilia-Romagna stations of the annual maxima and of maximum daily 8 hours average (2007-2012)

Why is it happening?
Air pollution emissions

Increasing anthropization represent the main cause of air pollution

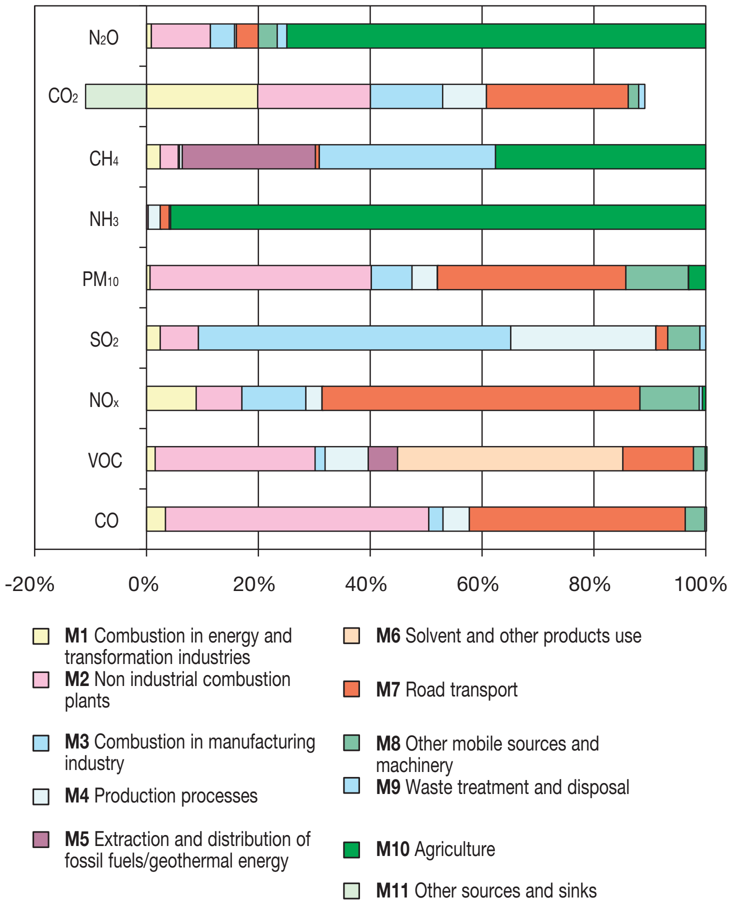
The increasing anthropization, especially in the Po valley areas, represents the main cause of air pollution. It is associated with increasing demands for energy, mobility and industrial development leading to the consequent emission loads.

Road transport, non industrial combustion, agriculture and production processes are the most critical macro sectors

The main sources of pollutants related to PM and ozone pollution are the following macro sectors: "road transport", "non industrial combustion", "agriculture", and productive activities ("industrial combustion", "production process" and "solvent use"), with varying relative contribution. "Non industrial combustion" and "road transport" respectively account for 40% and 34% of PM_{10} total emissions. "Road transport" is the main source of emission for NO_x, together with combustion processes related to industrial activities and energy production. NO_x, volatile organic compounds (derived from "solvent use") and ammonia (derived from "agriculture") are important precursors of secondary aerosols (particulate matter) and ozone.

The consumption of diesel fuel for trucking, agriculture and solvent use represent the largest emission source of precursor of PM_{10} and ozone secondary pollution (NO_x, NH_3 and VOC)

The diesel fuel consumption for transport is responsible for 63% of NO_x emissions; with regard to PM_{10}, the contributions from woods combustion, motor vehicle fuel and "no combustion activities" (brake and tire wear, road surface abrasion) are equivalent each other. Agriculture is a major contributor to ammonia emissions, with 96%. Solvents use in certain industrial and non-industrial activities is the main source of volatile organic compounds emissions, which, together with NO_x, are important precursor gases of secondary PM and ozone.



Source: Arpa Emilia-Romagna

Figure 10: Contribution to Emilia-Romagna emissions of principal air pollutants (N_2O, CO_2, CH_4, PM_{10}, NH_3, SO_x, NO_x, VOC, CO) from main source sectors (year 2010)

Why is it happening?
Climate factors

Topographic characteristics of the Po basin affect climate

The climate of the Emilia-Romagna region, located in the south eastern part of the Po valley, is strongly influenced by the topographic characteristics of the Po basin. The Po valley is a large plain bounded on the north and west by the Alps, by the Apennines on the south and by the Adriatic sea on the east.

Stagnation of air masses within the Po basin causes pollution

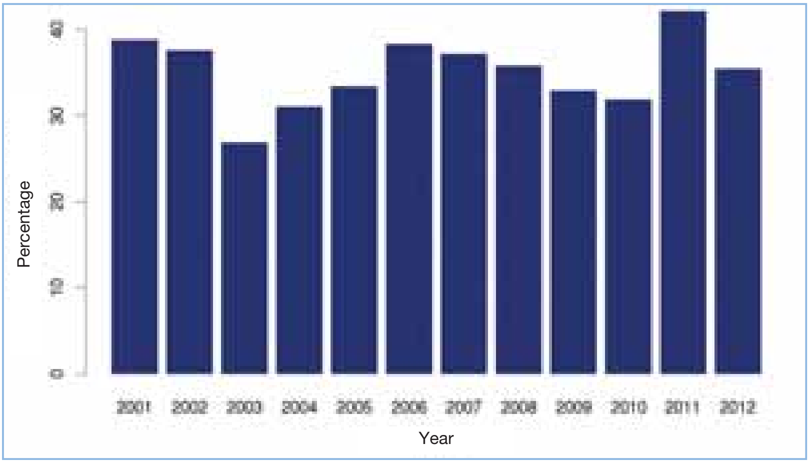
The Alps and the Apennines limit the atmospheric circulation, preventing the dispersion of pollutants, favoring the stagnation of air within the Po basin and, hence, leading to severe episodes of air pollution.

In winter meteorological conditions favors PM_{10} and NO_2 accumulation

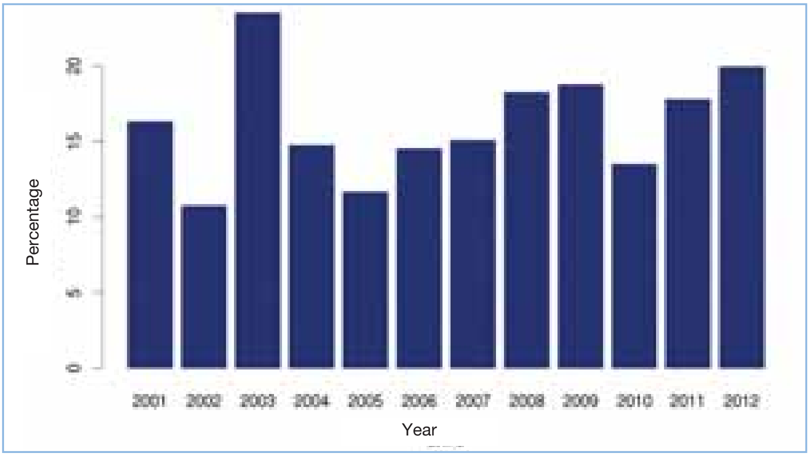
During the winter season the formation of a large-scale anticyclonic system on the north part of Italy favors the occurrence of temperature inversion and low mixing height events, in particular at night. Under these conditions, which sometimes persist for the whole day, the dispersion of pollutants emitted at ground level is strongly limited, causing the formation of strong PM_{10} and NO_2 pollution near heavily anthropized zones, like industrial areas and large urban centers. These acute pollution episodes often affect a large portion of Emilia-Romagna.

In summer meteorological conditions favors ozone formation and chemical air mass stagnation

During the summer, typical conditions are characterized by low ventilation, intense solar radiation and stationary high pressure. In such conditions, the heating of soil leads to strong convective mixing and local breeze regimes of the superficial layers of the atmosphere of the Po valley, which favor the dispersion of pollutants such as PM_{10} and NO_2; this high solar radiation promotes the formation of ozone, which reaches high concentrations throughout the whole area, including Appennines and Prealps.



Source: Arpa Emilia-Romagna
Figure 11: Percentage of days favourable to PM_{10} accumulation (2001-2012)



Source: Arpa Emilia-Romagna
Figure 12: Percentage of days favourable to ozone formation (2001-2012)

What are we doing?

10 years of air Quality Programmes

Since 2002 the Regions, Provinces, Chief towns and cities with more than 50.000 inhabitants have signed to Air Quality Agreements entailing actions to reduce emissions of the most critical pollutants, PM_{10} and NO_2. In urban areas the main strategies involve sustainable mobility and traffic limitations. In 2012 the Region set regulations for biomass and biogas combustion for energy production. These impose a "zero balance" for PM_{10} and NO_2 emissions in areas where the limit values for these pollutants are exceeded or risk to be exceeded. On July 26th 2012 the 10th Air Quality Agreement was signed with a three-year perspective. It contains a package of structural measures for at least 35 M€ and emergency actions in case of PM_{10} pollution peaks.

The results

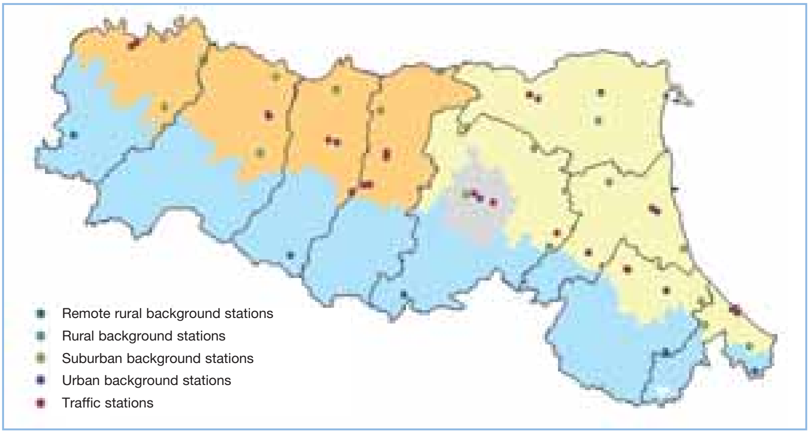
All the actions enforced in the past ten years have led to a significant reduction in the level of critical pollutants, such as PM_{10} and NO_2: annual mean concentrations of PM_{10} and NO_2 have decreased and the number of exceedances of the 24-hour limit value has reduced. Examples of other achievements include 46% in LEZ and pedestrian areas, 90% increase of cycle paths and the purchase of 1.640 new ecological buses.

The Po basin

Air quality in the Po Basin remains a serious issue despite all actions implemented by the regions that signed a common agreement in 2007. Some areas are now under infringement procedures for exceeding PM_{10} limit values. The main actions that need to be implemented in the Po basin regard the reduction of NH_3 emissions in agriculture, a decrease of diesel vehicles mobility and the regulation of biomass for domestic heating.

New Regional Integrated Air Quality Plan

In December 2012 the Emilia-Romagna Region adopted the guidelines for the elaboration of the Regional Air Quality Plan, which will define the emissions reduction targets for PM_{10} and NO_2, and their precursors. It will identify measures and actions to achieve these objectives through an integrated approach which involves all sectors engraving on air quality: transport, energy, agriculture, industrial activities, domestic heating, with a special attention to a sustainable management of urban areas.



Source: Arpa Emilia-Romagna

Figure 13: The zones and agglomerate of Emilia-Romagna region and the regional air quality monitoring network (DLgs 155/2010)

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