

**PROPOSAL OF CRITERIA FOR THE ASSESSMENT OF A POLLUTANT
REPRESENTATIVE LEVEL IN ZONES AND AGGLOMERATIONS TO BE COMPARED
WITH LIMIT VALUES AND TO BE USED FOR EVALUATION OF MEASURES
ADOPTED IN THESE AREAS.**

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INTRODUCTION

The analysis of the enforced norm regarding ambient air quality^{1,2,3,4}, indicates the identification of zones and agglomerations, through pollution levels assessment in each area, as starting point for air quality management and for Plans and Programs implementation.

In this paper, a methodology is proposed for the appraisal of the data to confront with air quality limits, in compliance with what indicated by EPA⁵. The methodology assesses air quality levels on the basis of mean values calculated as an average of all data collected in zones and agglomerates. The resulting value is certainly more representative of air quality in the area than a value obtained from a single station, especially if it is located in sites strongly conditioned from local sources.

ZONES AND AGGLOMERATIONS

In order to accomplish European directives Emilia Romagna Region has divided its territory into two main zones, A and B, characterised by different air quality levels, caused both by population density and industrial activity and from the peculiar orography and meteorology of the Po Valley.

Zone A is identified as the territory where the limit values and/or alert thresholds risk to be exceeded. It corresponds to the area of the Po Valley which is crossed by one of the main Italian route of communication and along which the main urban centres are located. In this area long term Plans and Programs for air quality improvement should be implemented.

Zone B includes the Apennine belt and its foothill where the values of air quality are lower than limit values. In this area Maintenance Plans in the long term should be arranged.

Agglomeration identifies the more densely populated part of zone A where the risk of exceeding limit values and/or alert thresholds is particularly high. In this area Action Plans must be implemented, with particular measures to be realised in the short term in order to respond quickly to alert situations.

This zones delimitation has originated from the assessment of the air quality, conducted by using data supplied from the fixed and portable monitoring network, from emission inventories and from the use of mathematical models.

The division of the territory follows the administrative borders, in compliance with the indications supplied from DM 261/2002 and L.R. 3/99, that delegated to Provinces the regional functions in matter of air quality planning and management. This results in the individuation of 9 zones A, 9 zones B and 12 agglomerates, articulated as in figure 1.

MONITORING NETWORK

As a consequence of this type of territorial division and of new criteria for monitoring stations positioning^{6,7}, a review of the existent monitoring network is necessary, because today it's almost totally concentrated in the city areas.

Therefore a deep modification is required in order to obtain reliable information all over the regional territory, and to allow a better use of the data, integrated from the information contained in the emission inventories, with the purpose of achieving a comprehensive assessment of ambient air quality in each type of zone.

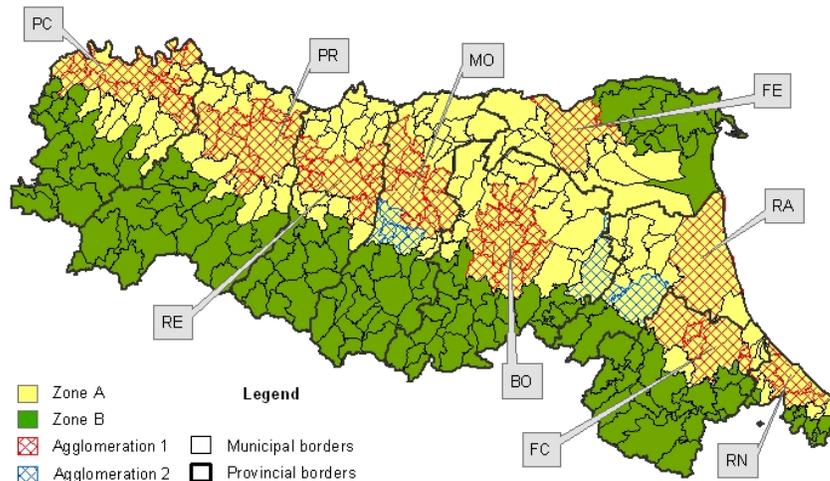


Figure 1; The Zones of Emilia Romagna Region

From the analysis of the data obtained until today and on the basis of the physical structure of the territory, it can be assumed that in zone B there are conditions of substantial respect of the limits of air quality; therefore such territory can be controlled with good reliability by one fixed monitoring station, endowed of sensors for the survey of PM₁₀, O₃, NO_x, SO₂, integrated with mathematical models.

As far as the zone A is concerned, conditions of exceedance of the limit values are probable particularly inside the agglomerations, especially for pollutants such as PM₁₀, PM_{2.5}, NO_x, O₃. The exceedance verifies mainly for secondary pollutants, such as PM₁₀, PM_{2.5}, produced mostly by traffic and energy production, and O₃ produced by photochemical reactions of pollutants emitted by the same sources.

For a reason of spatial representativeness the single station positioning must be carried out in such a way not to be influenced by local sources (such as traffic, industrial and energy production plants, etc.) or by obstacles in the nearby; as a consequence the typical station to be used for the appraisal of air quality is the one commonly defined “urban background” for zones A and agglomerations, and “rural” for zones B.

PM₁₀ monitoring network and compliance of the limit values

A survey of all PM₁₀ monitoring stations sited in zones A and agglomerations has been led in order to verify the number of sensors, their location in terms of area monitored and geographical coordinates, the respect of positioning criteria as an index of data representativeness.

In Italy an exceedance of daily limit value is counted when at least one station in the zone monitors a 24-hour value bigger than 50 µg/m³. The annual limit value in the area is exceeded when at least one of the stations overcomes 40 µg/m³.

As a consequence of this type of evaluation, in Emilia Romagna in 2004 the annual limit was exceeded in 7 agglomerates, while the 24-hour limit has been exceeded from a minimum of 4 to a maximum of 117 times, clearly quite far from the ceiling of the 35 times a year admitted.

The survey has highlighted that among the 33 PM₁₀ monitoring sensors operating in the Region, only 9 substantially respect the positioning criteria, thus produce data representative of the area.

Most of these PM₁₀ stations are traffic oriented and located in proximity of busy roads or crossings. In figures 2 and 3, two monitoring stations are shown, both sited in urban areas. The first station is clearly wrong positioned, (under the dropping line of trees, close to a petrol station and to a very busy street) and recorded in 2004 an annual value of 47 µg/m³ and 117 exceedances of the 24-hour

limit. The second station is correctly located and monitored in the same year an annual value of $28 \mu\text{g}/\text{m}^3$ and 34 exceedances.



Figure 2; Wrong location of a PM10 monitoring station



Figure 3; Right location of a PM10 monitoring station

In order to evaluate the effectiveness of air quality planning measures, a methodology of data assessment is proposed, based on an average approach extended on wide areas, such as regional zones and agglomerations.

DATA ASSESSMENT

The methodology proposed is based on calculation of hourly, daily and annual mean values, representative of the zones of Emilia Romagna Region and of the exposed subjects, surely more representative than a value from a single station.

Definitions

Hourly mean value: the data to compare with the 1-hour limit value derives from the average of the hourly mean values of each single station in the considered area. This results in 24 hourly mean values for the whole zone. The single data that differ more than 20% from the average of the area are discarded and the hourly mean values are recalculated and used for successive evaluations.

The discard of concentrations that are lower or higher of 20% of area averages should allow excluding all data affected by occasional pollution peaks or by a wrong sensor positioning.

Daily mean value: the data to compare with the 24-hours limit value (00:00 - 24:00) derives from the average of the hourly mean values and leads to a single daily mean value for the area.

Annual mean value: the data to confront with the annual limit value (solar year) is obtained by calculation of the average of the daily mean values.

The method might be applied to homogeneous zones on a regional level, or to single zones and agglomerations on a provincial level, as an index of air quality within the administrative borders of authorities competent in air quality planning.

Application of “average approach” to PM10 monitoring data

A comparison is shown for year 2004, between the result obtained by the common accounting of exceedances and the value obtained by the elaboration of PM10 data available with the “average approach”. The exclusion of concentrations that are lower or higher of 20% of area averages is applied in this case to 24-hour mean values because the actual limit value for PM10 is the daily mean.

As a first step the monitoring stations correctly positioned and representative of air quality on wide area has been selected among the 33 stations available all over the region. As previously cited only 9 stations follow EU indications on positioning, thus the “average approach” has been applied only to the data recorded by these ones.

In the following tables (table 1 and 2) the result of the comparison between the two methods is shown.

Table 1 reports the data transmitted to UE in compliance with article 11 of Directive 96/62/EC, which requires Member States to inform the Commission of the occurrence of levels exceeding the limit values plus any defined margin of tolerance. In the exceeding area competent authorities must prepare Plans and Programmes (article 8 of Directive 96/62/EC) to achieve limit values by the attainment dates. In Region Emilia Romagna all agglomerates exceeds the 24-hour limit value, thus each Province is expected to elaborates a Plan with measures aimed to improve air quality in urban areas.

Table 1; Usual counting of exceedances

| Data transmitted to UE | | |
|-------------------------------|------------|------------|
| PM10 n. stations 2004 | 33 | |
| | Min | Max |
| n. exceedances | 4 | 117 |
| Annual mean value | 22 | 47 |

Table 2 shows the data elaboration of the 9 stations selected, following the procedure described above. All data has been used even if less of 90% of yearly data where available for the stations. This limit loses significance when an average on all hourly values is calculated.

The results obtained are representative of the whole zone A of Emilia Romagna. The annual mean value is attained, while the 24-hour mean value is not respected but only for one exceedance.

Table 2; Average counting of exceedances and annual mean value

| Average approach | |
|------------------------------|----------------|
| PM10 n. stations 2004 | 9 |
| | Average |
| n. exceedances | 36 |
| Annual mean value | 30 |

CONCLUSIONS

In order to be able to evaluate the effectiveness of measures implemented to improve air quality in urban areas, Regions and Provinces should rely on an efficient and representative monitoring network.

The survey conducted on PM10 stations in Emilia Romagna and the comparison between the two approaches to data evaluation has shown the importance of a correct positioning of sensors and the necessity of an air quality assessment on wide area, such as on a regional level.

Emilia Romagna has started a deep process of revision of its monitoring network in order to meet the positioning requirement of UE directives. This will lead to a strong reduction in the number of stations, with a decrease of operating costs, and to a more homogeneous distribution of sensors among agglomerations, zones A and zones B. The data available will be then representative of the whole agglomeration or zone and the “average approach” should efficiently exclude pollution peaks due to occasional natural or local anthropogenic phenomena and to wrong sensor positioning.

Air quality in Emilia Romagna is quite a critic issue, in large part due to the orography and meteorology of the territory: the Po Valley has a peculiar meteorological situation that leads to dominant periods of atmospheric stability that brings to accumulation of pollutants at low altitude.

Moreover urban centres, built in ancient times, have narrow streets that don't allow an easy dispersion of pollutants emitted mostly by traffic. All the valley is densely populated and extra-urban tissue has grown without interruption.

The criticality is then not only on regional level but it involves all regions insisting on the Po Valley, such as Lombardia, Piemonte, Veneto. Air quality assesement should be carried out on a Valley level.

As far as planning is concerned, Region Emilia Romagna has devolved to Provinces the activity of establishing measures to apply in their area in order to improve air quality levels and to attain European standards. The advantage of this choice is that Provincial Authorities have a better knowledge of their territory and of local issues than Regional authority. On the other side the actions should be coordinated on a wider level in order to achieve homogeneity among all authorities insisting on the Po Valley basin.

REFERENCES

- ¹Council Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management.
- ²Council Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air.
- ³Directive 2000/69/EC of the European Parliament and of the Council of 16 November 2000 relating to limit values for benzene and carbon monoxide in ambient air.
- ⁴Directive 2002/3/EC of the European Parliament and of the Council of 12 February 2002 relating to ozone in ambient air.
- ⁵EPA: Code for federal regulation, Title 40, Volume 5, parts from 53 to 59.
- ⁶European Environment Agency: Criteria for Euroairnet, Technical report n. 12, February 1999.
- ⁷APAT CTN-ACE: Linee guida per la predisposizione delle reti di monitoraggio della qualità dell'aria, 2004.