Ambient Air Quality in the Republic of Macedonia from the Perspective of EU Directive

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AMBIENT AIR QUALITY IN THE REPUBLIC OF MACEDONIA FROM THE PERSPECTIVE OF EU DIRECTIVE

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Abstract: *In September 1996 the EU adopted Framework Directive 96/62/EC (FWD)[1] that defines the key principles of and general requirements for air quality assessment and management in subsequent (Daughter) Directives that lay down limit levels and specify in more detail the requirements concerning each of the pollutants declared in the FWD. The requirements of Directive 96/69/EC do not specify any detailed rules for zone delineation. In this paper we analysis the ambient air quality on the Republic of Macedonia. We have made analysis of the Directives' requirements in respect of air quality management area delineation - zones and agglomerations. The evaluation is made on the basis of the regular measurements obtained from the three existing measuring networks as well as via measurements of the emissions from stationary and mobile sources in several years period. Results from the analysis of SO_2, NO_2, NOx, PM_{10} and ozone concentrations are presented both for specific regions and on the entire state territory. Delineation on zones and agglomerations according to statistical regions is also performed, in line with the preliminary assessment of the air quality according to the measured parameters. We end with several recommendations for improvement of air quality in the given region and for future research work based on these results.*

Key words: Ambient air quality, preliminary assessment, SO_2, NO_2, PM10, zones, agglomerations, models.

1. Introduction

The WFD requires member states to divide their territories into zones with air quality assessment and management, thereby providing administratively for the most suitable air quality assessment and management throughout the member state. The detailed limits for each substance of interest are set out in a series of daughter Directives (Directive 1999/30 [2], SO_2, NO_2 and NOx, Particulate matter and Pb, Directive 2000/69/EC [3], Benzene and CO, Directive 2002/3/EC [4] OzoneZones are therefore the primary units for air quality management, and the Directives specify requirements for air quality assessment in each of the zones. To create a suitable system of zones in a country the following procedure is recommended:

- Perform preliminary air quality assessment throughout the country, taking into account all relevant parameters (annual average, exceedance of daily and hourly limit values), The detailed limits for each substance of interest are set out in Directive 1999/30 [2], SO_2, NO_2 and NOx, Particulate matter and Pb, and Directive 2002/3/EC [3] Ozone
- Identify areas with the same air quality characteristics (exceedance of concentrations, emission sources, climate, topography), create air quality maps,
- Project air quality maps into map of country's administrative division. The borders of administrative units may serve for

- delineating zones or combining administrative areas with similar air quality characteristics.

The rest of the paper is organized as follows. In section 2 methods that are used for air quality methods are presented, while in Section 3 the results from the conducted measurements with strong analysis on the key components that affect this quality issue pointed by the expert group.

2. Methods

The requirements laid down in the Directives for air quality assessment methods in each of the zones depend on how deep pollution levels in the zones fall below the limit values.

For each pollutant the Daughter Directive lays down the upper assessment threshold – UAT and the lower assessment threshold – LAT. Assessment thresholds are lower than limit values LV and are defined as percentages of the limit value. The required method of assessment in a zone depends on whether the UAT level will be exceeded in the respective zone in preceding years. When a certain pollutant's UAT will be exceeded, very strict requirements are placed on it; when LAT but not UAT will be exceeded, less stringent requirements for assessment are laid down. When levels below LAT are measured everywhere least stringent requirements are applied.

The borders of administrative units may serve for delineating zones or combining administrative areas with similar air quality characteristics.

The ambient air quality directive does not stipulate measurements any longer as the only tool for determining levels in a zone, and envisages – depending on pollution levels – the use of modeling techniques and expert estimates and their combinations.

It is important to bear in mind in this context that distinguishing between measurement and other assessment methods (interpretation, spatial interpolation of measurements, modelling) is not as clear-cut as is often thought. Measurement alone (i.e. measurement without any generalization) provides incomplete information while the other extreme, modelling alone (i.e. model application without verification) provides information lacking credibility.

The Guidance on Preliminary Assessment [4], suggests that three components be used as part of the assessment process;

- preliminary measurements,
- modeling, and
- air emission inventories.

Technical report No 11: Guidance report on preliminary assessment under EC air quality directives [5],, recommends that the results be primarily produced as maps referring to limit or target values for the pollutants under consideration using a normal map as background, perhaps using grid grey scales to show the percentage of the limit value. This advice is reflected by using colored scales given in Table 1.

Table 1. Colored scales to indicate the pollution level assessed in each square.

Parameter	Color
Annual Average above Limit Values:	Black
Between Limit Values and UAT:	Red
Between UAT and LAT:	Yellow
Below LAT:	Green

2.1. Monitoring systems and methodologies applied in Macedonia

Assessment is done with all the data available from the automatic monitoring systems in the MoEPP and HMA measurement programs.

a) Automatic Air Monitoring System (MoEPP)

Table 2. Methodologies used for air quality monitoring.

Parameter	Methodology
SO_2	Ultraviolet Fluorescence Method (UV)
CO	Non-Disperse Infrared Analyzer Method (NDIR)
NOx	Chemi-luminescence Method (CLD)
O_3	Ultraviolet Absorption Method (UV)
SPM	Beta-ray method

b) Monitoring stations of the HMA

Table 3. Methodologies used for air quality monitoring.

Parameter	Methodology
SO_2	Tetrahloro mercurate/ West-Gacke method
Black smoke	Standard British Reflectrometric Method
NO_2	OGAWA-USA Method
O_3	Jodometric Method

3. Results

3.1. Sources of pollution

The biggest individual sources of pollution are REK Bitola (located at Pelagonija Valley), FENI Industry (located at the most famous vinery area), SILMAK (Polog Valley) and OKTA (Skopje Valley).

In 2004 the oil refinery OKTA discharged 174 kg/h SO_2 from a 150 m stack. Simple calculations suggest that the SO_2 annual average concentration would be 2.32 $\mu g/m^3$ or less. NOx from OKTA would give rise to a maximum ground level concentration of about 0.48 $\mu g/m^3$ or less.

Only REK BITOLA and TEC-Oslomej Thermal Power Stations would likely affect SO_2 levels in air significantly when judged against the directive. Simple calculation [6] shows that annual average values would probably be about 30 $\mu g/m^3$ or less. This seems to correspond with the slight elevation in SO_2 levels noted in measurements in Bitola when compared to other towns.

Similar simple calculation shows that TEC Oslomej, near Kichevo, would give rise to an annual average of about 25 $\mu g/m^3$ or less from a 180 m stack.

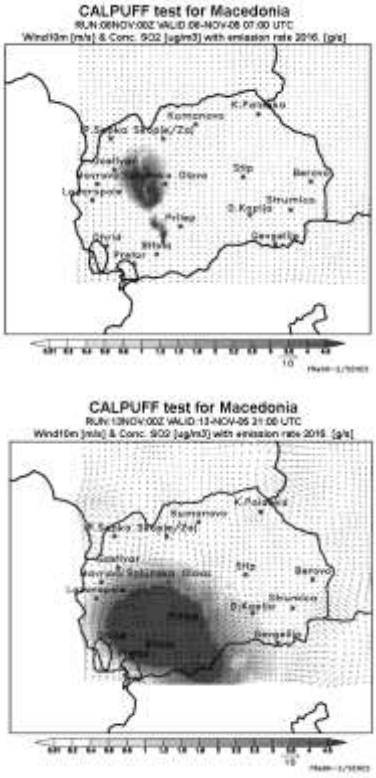

Figure 1. Emission of SO_2 according to CALPUFF model [9] and corresponding puffs.

3.2. Exceedance of air quality limit values in regions of Macedonia

According to Fig.2, annual average PM_{10} values exceeded the EU annual limit values in all stations except Lazaropole, an EMEP station located at 1100 m a.s.l. in the west region.

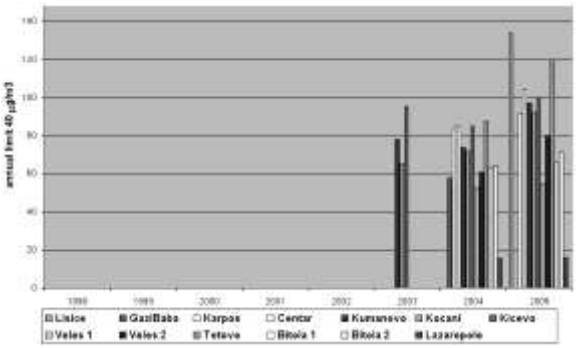

Figure 2. Annual average PM_{10} values in Macedonia

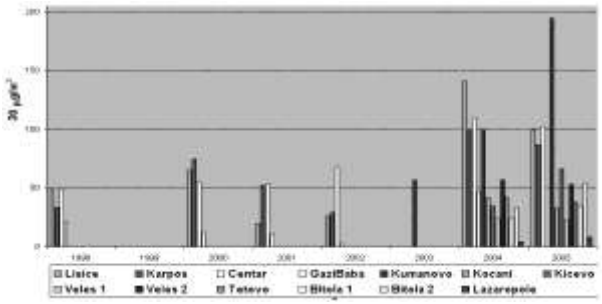

Figure 3. Annual average values for NOx (annual limit value 30 μg/m^3 set for protection of vegetation) in Macedonia.

Annual limit of NOx set for the protection of vegetation in Macedonia is not exceeded only at measurement stations in Veles1 (Vardar region) and Lazaropole.

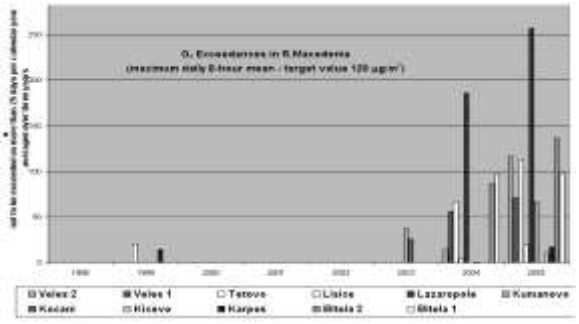

Figure 4. 8-th hours exceedance values for ozone (O_3) in Macedonia.

8-hour exceedance values for ozone in 2004 and 2005 were recorded only in Lazaropole and Veles2 stations.

Average winter values for SO_2 were exceeded in Skopje, Veles, Kumanovo, Stip and occasionally in Bitola cities.

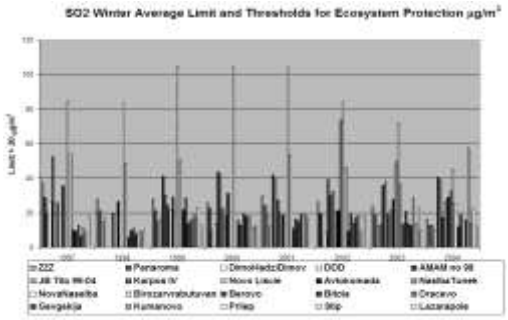

Figure 5. Average winter values for SO_2 regarding the protection of ecosystems in Macedonia.

3.3. Calculated and statistical maps of maximal admissible levels in the statistical regions in Macedonia

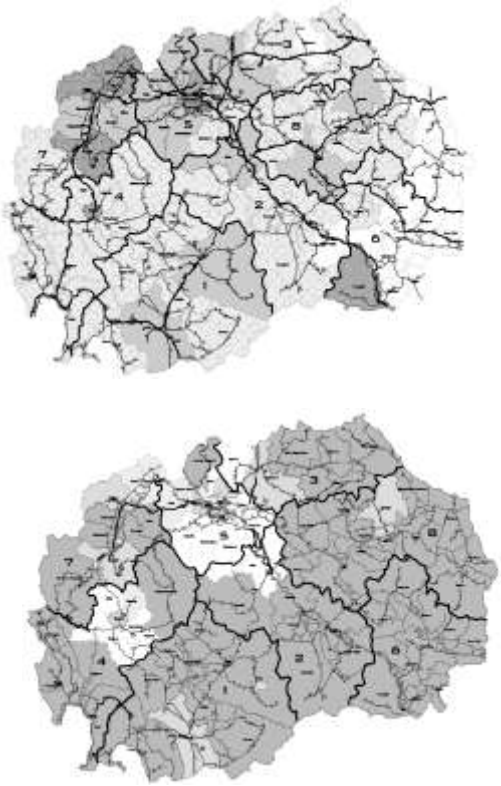

Figure 6. Annual average concentrations of PM_{10} (above) and annual limit of NOx set for the protection of vegetation in Macedonia (below).

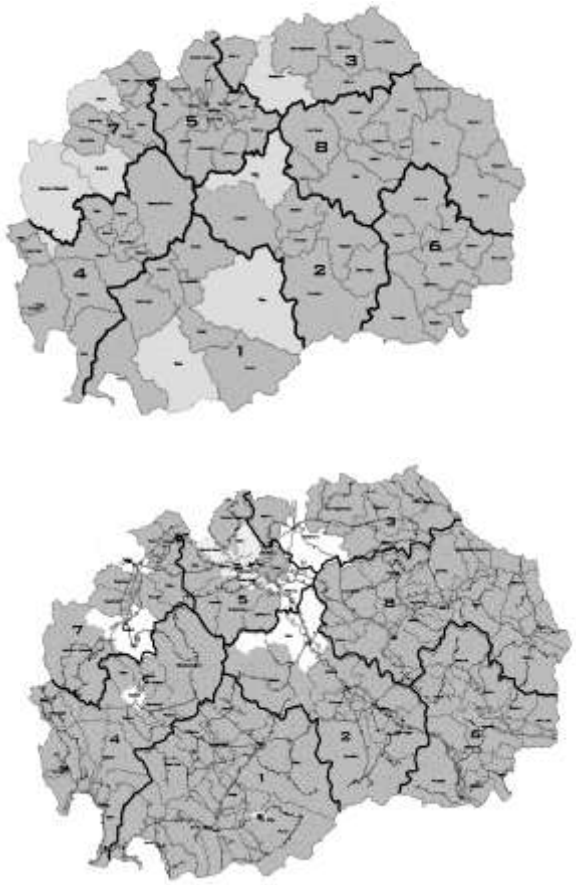

Figure 7. Maximum daily 8-hour exceedance values for ozone in 2005 (above) and average winter values for SO_2 was exceeded in Skopje (below).

Maps on Fig. 6 and 7 represent a summary of all assessments for each of the compounds, created by integrating the layers of the respective air quality classes for the 2005 year.

4. Discussion and Recommendations

Discussion and recommendations given in this section are founded on the results given by the previous maps and measured data obtained from the measuring station.

- In Zone 1, it would be desirable to set up a further monitoring station for NO_2 and PM10 in Prilep. An action plan will be needed to address NO_X.
- In Zone 2, the conditions for monitoring are met but the effect of the FENI installation on the environment should be examined when the IPPC application is made.
- In Zone 3, the conditions for monitoring are met. An action plan is needed for NO_2 though not necessarily for NO_X as the region is not judged to have significant agriculture.
- In Zone 4, the conditions for monitoring are met but it might be helpful to place a monitoring station for PM10 in Ohrid. An action plan may be needed in respect of Kichevo for NO_2 but not for NO_X as there is no significant agriculture in the area.
- In Zone 5, the conditions for monitoring are met. An action plan may be needed for the Centar District of Skopje and more generally for NO_2. An action plan for NO_X may not be needed if the area is judged not to be significant for agriculture. A study should be made of the effect of MakSteel and OKTA on air quality, probably when the operators make an application for authorization under IPPC.
- In Zone 6, the region needs to be equipped with a monitoring station to measure the main pollutants to meet the formal conditions of the directives by measurement alone. No action plan is required for any substance.
- In Zone 7, there needs to be one more monitoring station to measure CO and PM10 to meet the requirements of the directive by measurements alone. In addition there needs to be additional monitoring of NO_2 and PM10 in ambient air at Jegunoivce in the vicinity of Silmak. An action plan is needed for NO_2 in the vicinity of Silmak and more generally for NO_X as there is significant agriculture in this area. The national plan for PM10 will need to consider the effect of Silmak on air pollution nationally.
- In Zone 8, though not a formal requirement of the directives, a further monitoring station should be established in the region. Other than the national plan for PM10, an action plan will be needed for NO_X as this is an important area for growing rice.

5. Conclusions

In this paper we have analyzed the results from the measuring station in Republic of Macedonia for the ambient air quality. Each of the figures are discussed, and based on these analyses, several recommendations are given. The ambient air quality in the Republic of Macedonia shows that national plan will be needed for PM_{10} as the limit values are exceeded in most zones. A national plan may also be needed for ozone where the objectives may be met by proportionate measures.

Based on this research results in future we plan to review the locations of all monitoring stations as part of the overall action plan, and document the reasoning behind the selection of each site. We plan a project which might consider modeling the effect of the existing large sources across the country as a whole to see what improvement this might bring when compared to other sources. This will be an important issue when considering what constitutes the Best Available Technique for each of the major plant and, importantly, the time allowed for the plant to reach new legislative standards.

6. References

[1] Council Directive 96/62/EC on ambient air quality assessment and management, 1996, p. 55 – 63.

[2] Council Directive 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air, 1999, p. 41-60.

[3] Council Directive 2002/3/EC relating to ozone in ambient air, 2002, p. 14-30.

[4] EC Guidance on Assessment under the EU Air Quality Directives Air Quality Steering Group, 1998, p. 26-29.

[5] R.van Aalst, L. Edwards, T. Pulles, E.de Saeger, M. Tombrou, D. Tonnesen, Technical report No 11: Guidance report on preliminary assessment under EC air quality directives, 1998, p.48-51.

[6] Horizontal Guidance Note IPPC H1Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and Appraisal of BAT: UK Environment Agency, 2003, p.22-23.

[7] USEPA, 1995b. “User’s Guide for the CALPUFF Dispersion Model”, Prepared for the Office of Air Quality Planning and Standards, Research Triangle Park, NC, EPA-454/B-95-006,(July,1995).