Justification report on the contribution of natural events to the PM_{10} daily limit value

(reference to assessment questionnaire form 23a)

Malta Environment and Planning Authority

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1.0 Introduction

Being a Mediterranean county, Malta is frequently affected by dust loaded air masses advected from the African continent as well as from particles created from sea spray. Significantly elevated concentrations of well above 300 µg/m^3 as hourly averages and more than 200 µg/m^3 as daily averages have been monitored at Malta's background station since its commissioning in June 2007. As laid down by Directive 1996/62/EC and Daughter Directives and also in the new Air Quality Directive (Directive 2008/50/EC), Member States have the possibility to deduct the contribution of natural sources to the measured PM_{10} concentrations. Malta is adhering to this provision for the first time in line with Decision 2004/461/EC for reporting year 2008. Malta could not deduct the natural contribution from PM_{10} levels before this time due to the lack of guidance on the methodology to be used, and due to the few data available at background sites. In mid-2009, the European Commission circulated a draft version of a document entitled "Guidance on the quantification of the contribution of natural sources under the EU Air Quality Directive 2008/50/EC" to Member State experts. This document is the basis for the upcoming sections of this report.

2.0 Contribution from Sahara dust events

Figure 1 depicts 2008 PM_{10} daily averages measured at the background site (MT0007A) and at the traffic site in Msida (MT0005A). Msida is the only monitoring site, where more than 35 exceedances of the daily limit value were recorded in 2008. The two stations are 33 kilometres apart. Due to the fact that the Maltese territory comprises only 316 km^2, one can reasonably assume spatial consistency and that the Maltese archipelago is fairly homogeneously affected in the case of a transboundary and/or natural contribution. Figure 1

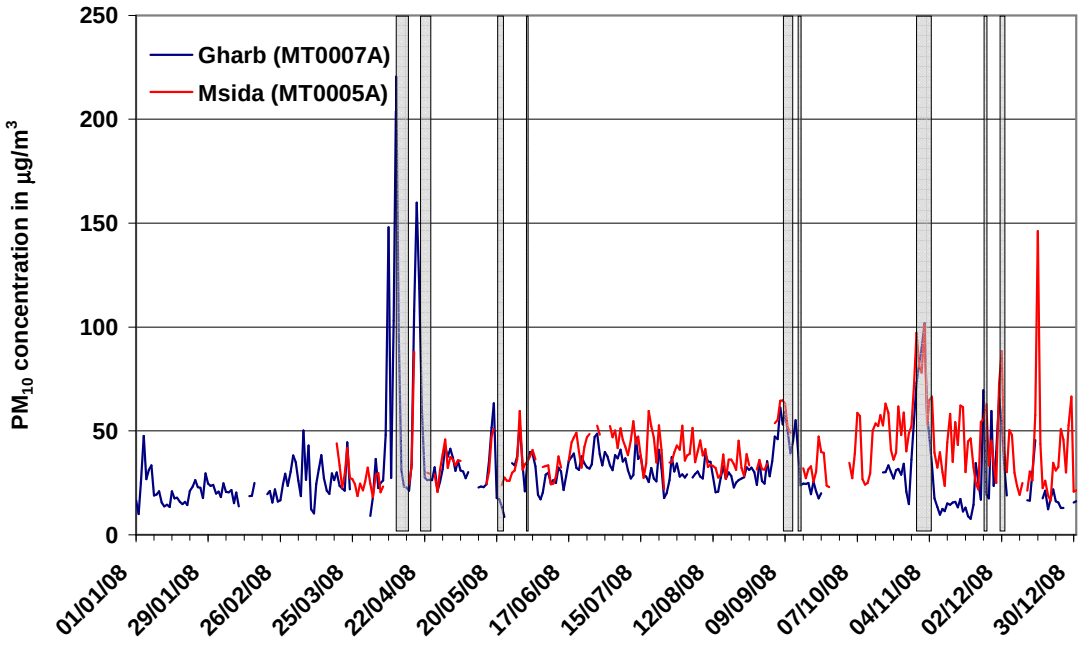

Figure 1: Daily averages of PM_{10} measured at the background station MT0007A and the traffic station MT0005A in 2008.

confirms this and the PM_{10} concentrations repeatedly experience episodes of high concentration at both stations.

In 2008, 25 exceedances of the daily limit value were monitored at the background site in Gharb, while 52 were monitored at the traffic site in Msida. All exceedances monitored in Gharb were identified to be of mainly African origin and are marked in Figure 1 as grey periods. Basis for the identification of Sahara dust events is the methodology also described in the guidance document provided by the *European Commission (2009).* The PM_{10} measured in Malta and in particular at the background station in Gharb (MT0007A) were analysed in detail by *Axisa (2009)* using backward trajectories, satellite images, $PM_{2.5}/PM_{10}$ ratios and chemical speciation of low volume sampler filters in order to identify their likely origin. This study is also the basis for Malta's notification for time extension application to meet PM_{10} limit values (*MEPA, 2009a*) and provides all relevant information on the Maltese climate and prevailing meteorological conditions as well as the position of the Maltese air monitoring network.

Date	Measured concentration at background station MT0007A	Contribution of African dust	Measured concentration at traffic station MT0005A	Resulting concentration at Traffic station after deduction of natural contribution
	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
18.04.2008	107.7	78.9	88	9.1
19.05.2008	63.2	34.6	50.9	16.3
29.05.2008	53.3	24.7	59.5	34.8
07.09.2008	61.2	32.3	64.5	32.2
08.09.2008	53	24.1	64.6	40.5
09.09.2008	59.1	30.2	63.2	33
10.09.2008	50.1	21.1	51.7	30.6
29.10.2008	54.9	32.4	71.9	39.5
30.10.2008	73	50.4	97.2	46.8
31.10.2008	82.3	59.7	81.4	21.7
01.11.2008	89.9	67.3	77.9	10.6
02.11.2008	101.9	79.4	101.1	21.7
03.11.2008	57.5	34.9	52.8	17.9
25.11.2008	69.6	50.7	55.3	4.6
01.12.2008	65.7	46.7	72.2	26
02.12.2008	54.4	35.5	88.4	52.9

Table 1: Resulting PM_{10} concentrations following deduction of African dust contribution for various days of exceedance.

From the exceedances, measured at both stations, 16 were found to be common. As described in the Guidance of the *European Commission (2009)*, the regional and temporary background concentration was determined by averaging the background measurements approximately 15 days before and after each particular episode. The resulting surplus was then subtracted from the respective values of the traffic station in Msida. The table below shows that the remaining

PM_{10} concentrations at Msida are now below 50 $\mu g/m^3$ for 15 of the 16 days in question. As a result the number of exceedances at the traffic station in Msida dropped from 52 to 37.

It should be noted that this analysis covers only days on which the PM_{10} concentration exceeded the 50 $\mu g/m^3$ daily limit value at the background site. However, one can certainly assume that the Mediterranean and therefore the Maltese Islands are also affected by milder and less apparent forms of intrusion of dust from the African continent, which obviously add to the local anthropogenic contribution. However, it will be increasing difficult to identify such milder events and accurately quantify them without appropriate modelling.

3.0 Contribution from sea salt

Being surrounded by sea it is obvious that Malta is also affected by sea spray especially during strong wind conditions. In fact a lot of salt can be found on the impaction plates of the sampling heads. It seems to be evident that the prevailing concentration of sea salt at a particular site is a complex phenomenon. On the other hand, one can also reasonably assume that, once PM_{10} is formed from sea spray, it will disperse rather equally over the Maltese territory due to the large scale weather conditions, which leads to its formation in the first place. However, key factors are certainly the distance from the shore and the wind speed. The contribution of sea salt to the PM_{10} concentration was therefore also investigated. The guidance (*European Commission, 2009*) provides a method on how to calculate the sea salt concentration from measured chloride and sodium concentrations. In 2008, a total of 38 PM_{10} low volume sampler filters were collected from the traffic site in Msida and analysed for ions. As described in the guidance the concentrations of chloride and sodium were used to calculate the contribution of sea salt using the following formula:

$$[\text{Sea salt}] = 1.176*([Na^+]+[Cl^-]).$$

The resulting average sea salt concentration at Msida is 3.1 $\mu g/m^3$ with a maximum of 14.5 $\mu g/m^3$. Low volume sampler filters were also collected from the background site using a Partisol sampler with a dichotomous inlet. Since the inlet of this sampler deviates from the one required by the relevant standard (*MSA EN 12341, 2000*), equivalence testing is currently being carried out (*MEPA 2009b*), but has not been concluded. Thus, no correction was applied on this data for the time being. The average sea salt concentration in Gharb in 2008 was 2.7 $\mu g/m^3$, which is in agreement with the average value determined in Msida.

Although the average sea salt concentration is quite similar at both stations an analysis of samples collected from both station on same days revealed some discrepancies, which may be a result of the difference in distance from the sea and/or different topography between the stations. The background station is about 700 metre closest to the northern shore. Its altitude is 114 metre above sea level. On the other hand, Msida station is situated at sea level at the end of an elongated bay opening to the North-East. Hence, further research needs to be carried out in order to identify the local influencing conditions determining the sea salt concentrations at the particular sites. However, in order to get an idea of the contribution of sea salt to the PM_{10} fraction, when no ion measurements are available, the correlation between wind speed and sea salt concentration was analysed. Figure 2 depicts the correlation between the daily sea salt concentration and the daily average wind speed at the background site in Gharb. Gharb was chosen because much more data is available from this station (198 days for the period from June 2007 until December 2008). Since it is situated higher and in a

greater distance from the shore line it is more likely that the sea salt concentrations are lower at this site than at the station in Msida. The data set was analysed for outliers and six data pairs (depicted as red dots in Figure 2), outside the 95% confidence interval, were excluded from the further orthogonal regression calculation. The correlation coefficient $R^2 = 0.69$. It shows a relatively good correlation between sea salt and wind speed and it therefore suggests that "background" sea salt can be deducted by calculation for days when no ion measurements are available.

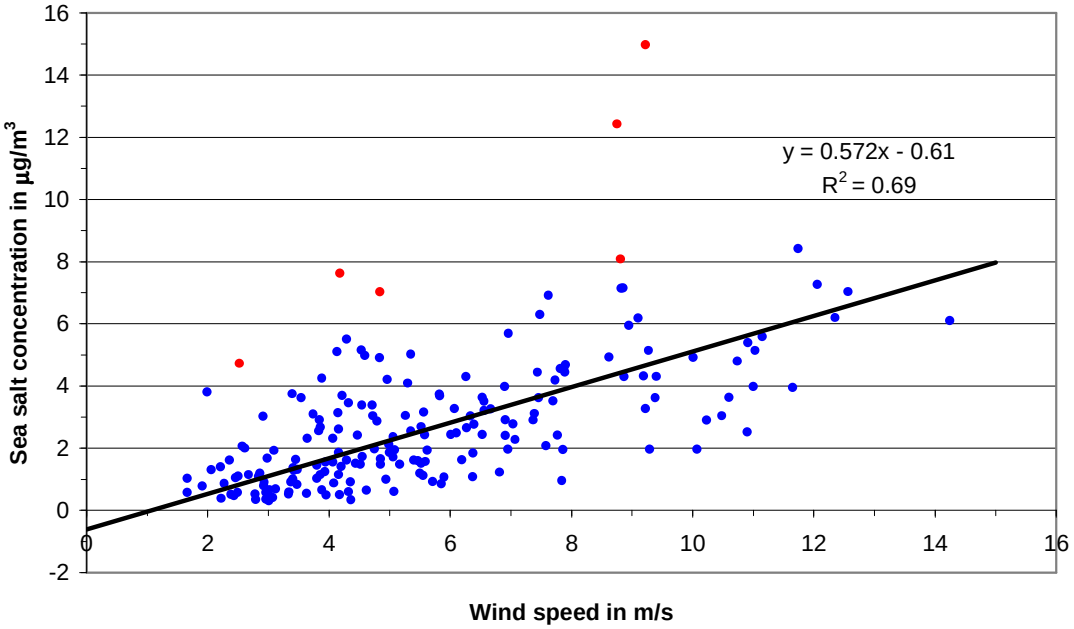

Figure 2: Correlation between wind speed and sea salt concentration in PM_{10} at the background station in Gharb.

The following approach was taken for subtracting sea salt contributions from the PM_{10} measurements at Msida. If available, the sea salt concentrations, determined from measured ion concentrations, were used. Preference was given to measurements of ions directly made in Msida, otherwise ion data from Gharb was taken. For days when no ion data is available, the background sea salt concentration was calculated using the daily average wind speed as described above (Figure 2). Additionally, a wind speed threshold of 2 m/s was applied, above which sea salt was calculated. As a result, further 6 exceedances due to sea salt can be deducted from the exceedance list of Msida station.

4.0 Conclusion

Only the traffic station in Msida (MT0005A) exceeded the daily limit value for more than the allowed 35 days, namely 52 days. The number of exceedances due to transboundary contribution of African dust proved to be significant, although the analysis was limited to apparent events only during which the daily PM_{10} values were also exceeded at the background station. This alone will lead to a reduction of the number of exceedances in Msida in 2008 from 52 to 37. The contribution of sea salt to the PM_{10} fraction was also

analysed, leading to the conclusion that further six exceedances can be deducted, reducing the number of PM_{10} exceedances in Msida to 31.

References

Axisa, N. (2009): Transboundary particulate matter in the Maltese Islands – A study on source identification, Unpublished, M.Sc. dissertation, University of Derby.

European Commission (2009): Guidance on the quantification of the contribution of natural sources under the EU Air Quality Directive 2008/50/EC, Draft version, DG Environment, July 2009.

MEPA (2009): Technical report accompanying Malta's PM_{10} time extension notification forms, Malta Environment and Planning Authority, October 2009

MEPA (2009a): Technical report accompanying Malta's PM_{10} time extension notification forms, Malta Environment and Planning Authority, October 2009

MEPA (2009b): Interim report on the equivalence study of automatic PM_{10} analysers in Malta, Malta Environment and Planning Authority, October 2009

MSA EN 12341:2000, Air quality – Determination of the PM_{10} fraction of suspended particulate matter – reference method and field test procedure to demonstrate reference equivalence of measurement methods, Malta Standards Authority