National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

SO_2 monitoring strategy

RIVM Letter Report 680704016/2011
Eric van der Swaluw| Ronald Hoogerbrugge|
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Abstract

SO_2 Monitoring Strategy

According to European legislation concentrations of SO_2 needs to be monitored at two sites in the Netherlands. In the current Dutch monitoring network (LML) there are twenty locations where concentrations of SO_2 are being measured. RIVM recommends measuring the concentration of this air pollutant at eight existing monitoring stations. Thereby not only satisfying EU legislation, but also criteria like for example acidification.

In the *Rijnmond* area an industry station from *DCMR Milieudienst Rijnmond* would be selected plus an urban background station from the LML. Furthermore it is recommended to distribute six regional LML monitoring stations with a homogeneous coverage over the Netherlands with a relatively more dense concentration of stations in the middle and southern part of the Netherlands. The latter covers the areas with intensive livestock farming, which are vulnerable to acidification.

Keywords: monitoring, strategy, sulphur dioxide

Rapport in het kort

SO_2 meetstrategie

Nederland voldoet aan de Europese meetverplichtingen voor zwaveldioxide (SO_2) als op twee locaties in Nederland concentraties van deze stof in de lucht wordt gemeten. In het huidige Landelijke Meetnet Luchtkwaliteit (LML) worden op twintig locaties de zwaveldioxideconcentraties gemeten. Het RIVM stelt voor om de concentratie van deze stof op acht bestaande stations te meten. Daarmee wordt voldaan aan de Europese meetverplichtingen maar ook aan andere criteria, zoals voor verzuring van de bodem.

In de Rijnmondregio zou een industriestation van DCMR Milieudienst Rijnmond hiervoor in aanmerking komen, evenals een stedelijk achtergrondstation van het LML. Aanbevolen wordt de overige zes regionale achtergrondstations gelijkmatig over Nederland te verspreiden, met een iets dichtere verdeling in Midden- en Zuid-Nederland. Hiermee worden gebieden met veel veehouderij, die kwetsbaar zijn voor verzuring, gedekt.

Trefwoorden: meetnet, zwaveldioxide, meetstrategie

Contents

1 Introduction

In the current Dutch monitoring network there are 20 locations where concentrations of SO_2 are being measured (see Appendix A for a list with the current SO_2 monitoring stations). This number of stations is the result of an earlier reduction in 2008 when 35 monitoring stations were still operational (Beijk et al., 2008). According to European legislation in the Netherlands SO_2 monitoring is required only at two sites. In this report we check which criteria need to be employed, next to the EU legislation, in order to reduce the current 20 monitoring stations to a number of sites that generates sufficient information to satisfy the monitoring goals aimed for.

2 Background information SO_2

2.1 Current concentration of SO_2

The concentration of sulphur dioxide in the Netherlands has shown a strong decrease over the last few decennia. However in the last couple of years this decrease has slowly stagnated. On a regional level the concentration has decreased from values of roughly 20 µg/m^3 towards values of approximately 2 µg/m^3. The decrease in the values of the concentration is a result of a decrease in emissions of sulphur dioxide in both the Netherlands and countries abroad. The highest concentrations in the Netherlands are being measured in the south western part of the Netherlands, where the most industrial areas are located. Figure 1 shows the mean and spatial distribution over the Netherlands.

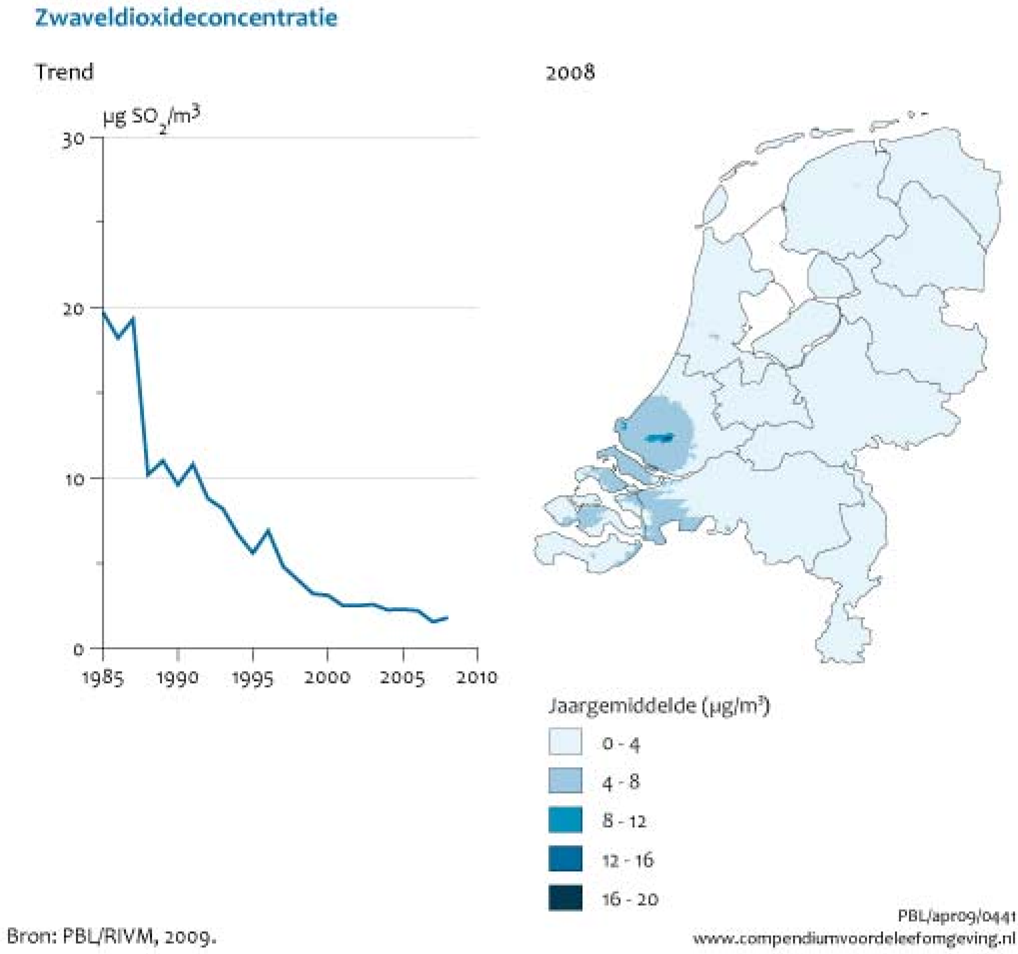

Figure 1 A summary of the SO_2 concentrations in the Netherlands in 2008

2.2 Current emissions of sulphur dioxide

The sulphur dioxide emissions in 2008 in the Netherlands are given in Table 1. The emissions of sulphur dioxide have decreased with approximately 73% in 2008 with respect to 1990. In 2008 the total emission in the Netherlands equals 51 kilotons. This value is determined according to the definitions from the EU with regard to the National Emission Ceilings (NEC) and therefore does *not* include the contribution from ship traffic. From the 51 kilotons of emission 92% of the emission comes from industry, 7% comes from traffic and transport and 1% comes from other sources. Ship traffic contributes an additional 40 kilotons to the emissions for 2008. The emission in ship traffic has decreased with 23% in 2008 with respect to 1990.

Table 1 Emissions of SO_2 in the Netherlands in 2008

Sector	Emissions (in kilotons)
Agriculture	0.06
Industry	47
Traffic and transport	3.4
Construction,trade,service and government	0.22
Housekeeping	0.51
Total (NEC):	**51**
Ship traffic	40
Total:	**91**

2.3 Origin of sulphur dioxide

There is only information available for the origin of the acid deposition in 2004. From this information percentages are derived for the origin of the deposition of oxidized sulphur in the Netherlands as stated in Table 2.

Table 2 Contribution of sources to SO_2

Source	Contribution
The Netherlands	25%
The North Sea	8⅓%
Abroad	50%
Background from hemisphere	16⅔%

Most important conclusion is that 50% of the deposition comes from abroad, which suggests that for the concentration of sulphur dioxide the contribution from abroad will most likely have a comparable percentage. Furthermore emissions from ship traffic on the North Sea are a very important contributor.

2.4 The different guidelines and the current configuration

2.4.1 *EU Framework and national guidelines*

In the Netherlands there are the EU framework guidelines and the national guidelines on which the configuration of the air quality network should be based. The limit value of SO_2 equals 125 µg/m^3 for twenty-four-hour averaged values and 350 µg/m^3 for hourly values. The lower and upper assessment thresholds for the twenty-four-hour averaged values equal respectively 50 µg/m^3 and 75 µg/m^3. The lower assessment threshold should not be exceeded more than three times in any calendar year. An assessment threshold shall be deemed to have been exceeded if it has been exceeded during at least three separate years out of the previous five years. The minimum number of monitoring stations required for SO_2 as required by European legislation 2008/50/EG was investigated in 2007. The outcome of the result is presented in column 2 of Table 3 (from the report LVM-LU-D4003).

Table 3 EU guidelines

Zone/agglomeration	2008/50/EG	1999/30/EG	Nl	LML
Amsterdam/Haarlem	0	1	2	1
Utrecht	0	1	2	2
Den Haag/Leiden	0	1	2	2
Rotterdam/Dordrecht	2	2	2	2
Eindhoven	0	1	2	1
Kerkrade/Heerlen	0	1	2	2
Zone North	1	0	2	3
Zone Middle	0	1	2	4
Zone South	0	0	2	3
Total:	**3**	**8**	**18**	**20**

The requirements for the number of stations to measure SO_2 from the earlier guideline on SO_2 from 1999/30/EG, the Dutch guidelines and the current LML configuration are also summarized in this table, in respectively column 3, 4 and 5. The data used for the report LVM-LU-D4003 was based on the observational data from 1999-2004. Since this does not cover the last five years, the period 2003-2008 was checked for SO_2 concentration values at all monitoring stations (using the Tables as presented in Beijk et al., 2007, 2008, 2009). It was found that the twenty-four hour averaged concentration at LML stations which has been exceeded on 3 days are all below the lower assessment threshold of 50 µg/m^3. However checking the twenty-four hour averaged values at DCMR locations which has been exceeded on 3 days over the same period (A. Snijder, personal communication), the maximum values of these concentrations are exceeding the lower assessment threshold values (see Table 4).

Table 4 The twenty-four hour averaged values of SO_2 (in µg/m^3) at DCMR locations which has been exceeded on 3 days.

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Max	78	50	91	74	79	56

From this update it is concluded that the recommendation done in the report LVM-LU-D4003 is still valid if one takes into account the measurements at DCMR as well, except for the monitoring station in Zone North. Therefore it is concluded that two monitoring stations are needed for the EU requirement.

2.4.2 *Proposal for hourly averaged norm in the USA*

In the United States it was recently proposed to introduce a limit value for SO_2 which is based on hourly averaged values. The US-EPA regulations require to use the fourth-largest hourly averaged value. The threshold value for the hourly averaged criterion is laid down to a value of approximately 200µg/m^3 (75 ppb). It was checked whether this USA criterion was exceeded in the LML network over the period 2003-2008. Figure 2 shows the two stations with the highest values occurring in the Netherlands over this period.

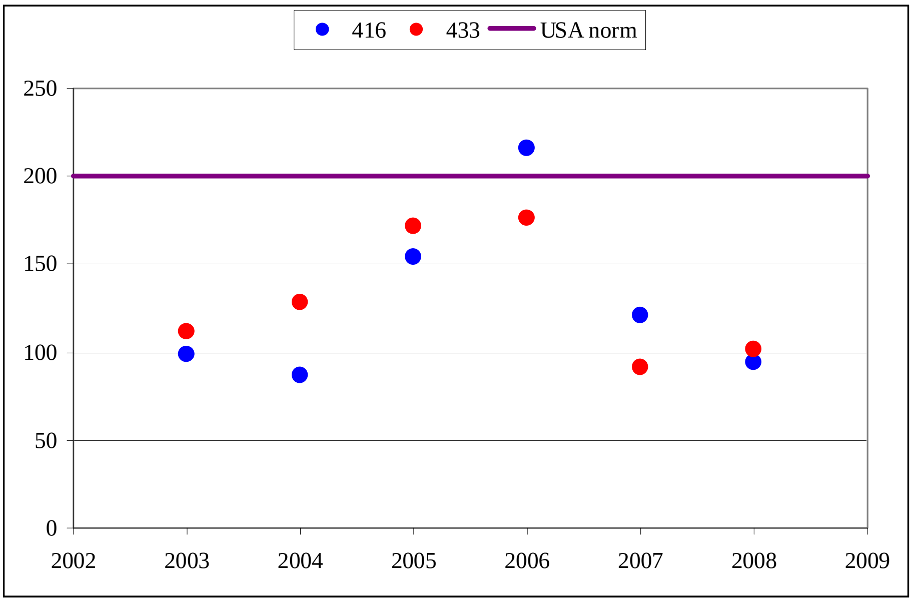

Figure 2 The fourth largest hourly averaged values for SO_2 (in µg/m^3) in the LML network over the period 2003-2008. Station 416 is a rural background station, whereas station 433 is a traffic station.

This Figure shows that if the USA norm would be employed it would most likely be exceeded in the Rijnmond area. An independent analysis was made by DCMR in which the same conclusion is reached. These results also argue for maintaining the two monitoring stations in the agglomeration Rotterdam/Dordrecht.

2.4.3 Conclusion

The conclusions of the report LVM-LU-D4003 regarding the 2 monitoring stations in the agglomeration Rotterdam/Dordrecht are taken over in this document. The twenty-four hour averaged concentration at LML stations which has been exceeded on 3 days are all below the lower assessment threshold of 50 μg/m^3 over the period 2003-2008. However, checking on the USA-norm, the station Vlaardingen is above the USA norm (see 2.4.2). Furthermore, the twenty-four hour averaged values of SO_2 (in μg/m3) at DCMR locations which has been exceeded on 3 are still exceeding the lower assessment threshold values (see Table 4).

3 Motivation for the number of monitoring stations

The following aspects play a role in pointing down the choice for the number of SO_2 monitoring stations needed in the Netherlands:

- SO_2 contributes to acidification;
- SO_2 contributes to the formation of particulate matter;
- Measurements are needed for controlling (inter)national conventions (NEC, Gotenborg) and keep track of long-term trends;
- Measurements are needed for detecting new sources in good time;
- Measurements to trace activities of ship traffic and harbors;
- Measurements are needed for validation and calibration of models.

Below we discuss the above mentioned aspects and point out their relevance for the LML network for SO_2. We end with a proposal for a strategy which takes into account the most important of the aspects mentioned above.

3.1 Discussion of topics related to SO_2

The distribution of SO_2 concentrations in the GCN-map over the Netherlands for the year 2008 is shown in Figure 3. There is a clear gradient observed from values of 3-4 $\mu g/m^3$ in the South-western part of the Netherlands to 1 $\mu g/m^3$ in the North-eastern part of the Netherlands. Areas with local sources are located in the provinces of Zeeland and Zuid-Holland and are typically higher than 5 $\mu g/m^3$.

3.1.1 SO_2 and acidification

The current SO_2 levels are so low that the EU threshold value of 20 $\mu g/m^3$ for nature areas is never exceeded during winter periods. However, the current sulfate deposition in the Netherlands is close to the deposition threshold value as set by NMP4. Especially in the areas of the province of Zuid-Holland and the Southern provinces this national deposition threshold value is exceeded by 25-50%. The threshold value for sulfate as set by MNP4 would correspond with concentration values of approximately 2 $\mu g/m^3$.

From the above it is concluded that the deposition thresholds for sulfate are still exceeded in the provinces of Utrecht, Zuid-Holland, Zeeland, Brabant and Limburg, whereas the province of Gelderland is just below the threshold value. In these areas monitoring activities should be maintained if one wants to continue monitoring the effects of acidification.

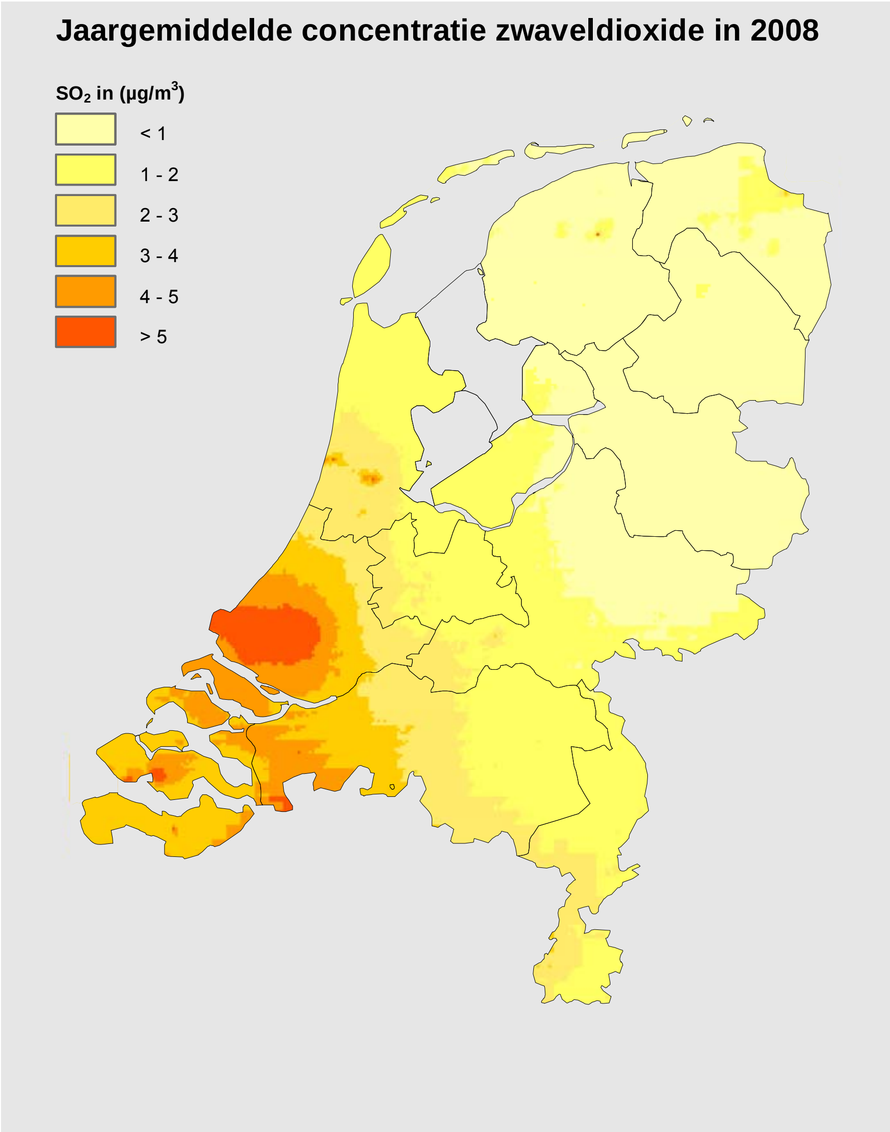

Figure 3 The SO_2 concentrations over the Netherlands in 2008 according to the GCN-map.

3.1.2 *SO_2 and particulate matter*

The oxidation of SO_2 in the air in combination with ammonia yields the ammonium sulfate aerosol, which contributes to the levels of particulate matter in the air. The conversion factor equals, order of magnitude, 5% per hour. Instantaneous measurements of the levels of ammonium sulfate in the air results from the concentrations in the air of SO_2 over a period of the last few hours since the half-life of conversion is of the order of 10 hours. This corresponds to an area of around 200 km, when the mean wind speed equals 5 m/s. This in turn implies that only the large-scale gradients have to be known in the Netherlands for SO_2 in order to determine the distribution of the sulfate aerosol. A typical configuration of stations to measure these types of gradients would be distributed like the five dots on a dice.

3.1.3 *Measurements for conventions and trends (NEC, Gotenborg)*

These conventions are intended to reduce the large-scale background values of sulfur and for tracing trends over long-time periods. Control over the trends could take place on large-scales in order to get a representative national mean value. This would again mean a typical configuration of five stations spread homogeneously over the Netherlands. Obviously this would be different if very specific regulation is required in which case more local areas would need to be monitored. This issue is not investigated in more detail since this type of monitoring activity would occur more on the level of provincial activity. Finally it is essential to trace and retain existing long-term time series, implying that it is essential to keep those monitoring stations for SO_2 measurements with long time series.

3.1.4 *The detection of new sources*

It is very difficult to fully take into account this aspect, if there is no knowledge available about what type of new sources would be expected. Very specific local sources can not be monitored by LML on large scales. The best strategy to detect new sources in good time would be to have monitoring stations homogeneously spread over the Netherlands.

3.1.5 *Ship traffic*

This is an example of the item mentioned in the previous subsection. In principle a number of monitoring stations near Rotterdam/Rijnmond should be maintained.

3.1.6 *Validation and calibration of models*

Model calculations are used to yield maps of SO_2 concentrations over the whole of the Netherlands. The measurements are used in these types of calculations for the purpose of validation and/or calibration. This combination of the usage of both measurements and modeling are based on the concept that one can not measure each source or gradient in SO_2 concentration over the Netherlands. The GCN-maps of concentration and deposition of components are based on OPS-model calculations which in turn are scaled by the measurements. In general the quality of the GCN-maps improves as the number of monitoring stations used for the scaling of the models is increased. In the case when a contaminant only has large-scale gradients which are smoothly distributed, one can suffice with a few monitoring stations which are able to measure the most important gradients. For the concentration of SO_2 the spatial distribution over the Netherlands is very smooth with peak values in urban and industry areas and higher concentrations near the Southern border of the Netherlands. In the production of the GCN-map of SO_2 concentrations a scaling factor is used which is determined by the ratio of SO_2 concentrations between the measured and calculated values of the OPS-model at the monitoring sites. This scaling is performed using the statistical method of Kriging. This method introduces a relative uncertainty of 45% at the 1-sigma level (Velders, personal communication): uncertainties of 1.2 µg/m^3 on a mean value of 2.6 µg/m^3. These numbers apply to the current situation with 12 LML stations (2008) being used. If one assumes that the uncertainty at the various monitoring locations is independent, then the uncertainty scales as $1/\sqrt{12/n}$, here n is the new number of stations. For 10 monitoring stations this yields an uncertainty of 50%, 8 stations would yield 55%, and 5 stations would yields 70%. It should be noted that at these small numbers of stations the uncertainty estimate based on these statistics does not hold. The uncertainty then becomes more or less a function of coincidence rather than a stochastic process. Therefore the uncertainty figures at low stations numbers should be seen as merely indicative.

How many monitoring stations are needed for SO_2 for the GCN-maps strongly depends on the desirable margins on the uncertainty. For SO_2, the concentrations in air are low, to the extent that the measurement uncertainty is acceptable on the level of 100%. For the contribution of SO_2 to the dry deposition of sulfur the uncertainty is different: in that case the uncertainty in concentration scales linearly with the deposition quantities. In the current situation the uncertainty in dry deposition of sulfur as a result of the configuration of the monitoring stations is around 45%. The sulfur deposition causes about 25% of the deposition of potential acid, so the total uncertainty in potential acid deposition as a result of the current configuration of the monitoring network is approximately 10%. If a reduction takes place to 6 regional LML stations, the uncertainty in dry deposition of sulfur as a result of the configuration of the monitoring stations is around 60-70%. So the total uncertainty in potential acid deposition as a result of the reduction from 12 to 6 regional LML stations would become 15%.

3.2 Conclusions

- The most compelling argument to measure SO_2 is acidification. The areas in the Netherlands which are vulnerable to this are the Southern provinces, Utrecht and Gelderland. A relevant question for acidification is whether threshold values will be checked on deposition of potential acid or whether there will be checks for sulfur deposition as well. In the first case, the uncertainty as a result of the 12 LML stations (2008) is smaller (~10%) than for the second case (15%). This increase in uncertainty is acceptable, especially since the new monitoring will be such that the required accuracy of the measurements should typically be 10% of the current concentrations. At the current levels of SO2 concentrations this would correspond with 0.2 μg/m3. This will improve the quality of the measurements;

- for the purpose of mapping/control/preservation a similar, homogeneous spreading over the Netherlands should be maintained;
- However it is of importance to have a number of monitoring stations located in the Rijnmond area for the purpose of keeping track of emissions due to ship traffic;
- for the purpose of validation/calibration a homogeneous spreading over the Netherlands should be maintained.

3.3 Recommendations

Four aspects should be taken into account for a monitoring strategy of SO_2:

1. a homogeneous distribution of monitoring stations over the Netherlands: this can be achieved with 5 sites spread like the dots of the number five on a dice;
2. additional attention should be paid to the Southern provinces, Utrecht and Gelderland, this would typically need five stations;
3. use current monitoring stations which also have a long time series, in order to keep track of long-term trends;
4. this document proposes a monitoring strategy in which monitoring stations from both the Dutch National Air Quality Monitoring Network and DCMR are used. In order for this network to get operational an official agreement between the partners RIVM and DCMR is recommended. It is very important that part of the official agreement should be a guaranteed continuity and equivalency of the monitoring stations of both partners.

4 A proposal for a new monitoring strategy

In order to meet EU requirements, 1 urban background station from the Dutch National Air Quality Monitoring Network together with 1 industrial site of DCMR, both in the agglomeration Rotterdam/Dordrecht, are selected. Additionally 6 regional sites are included for the purpose of monitoring the acidification in the Netherlands.

In the current monitoring configuration of SO_2 there are 12 regional background stations available (see Figure 4). A selection needs to be made from 12 to 6 stations, which is described below.

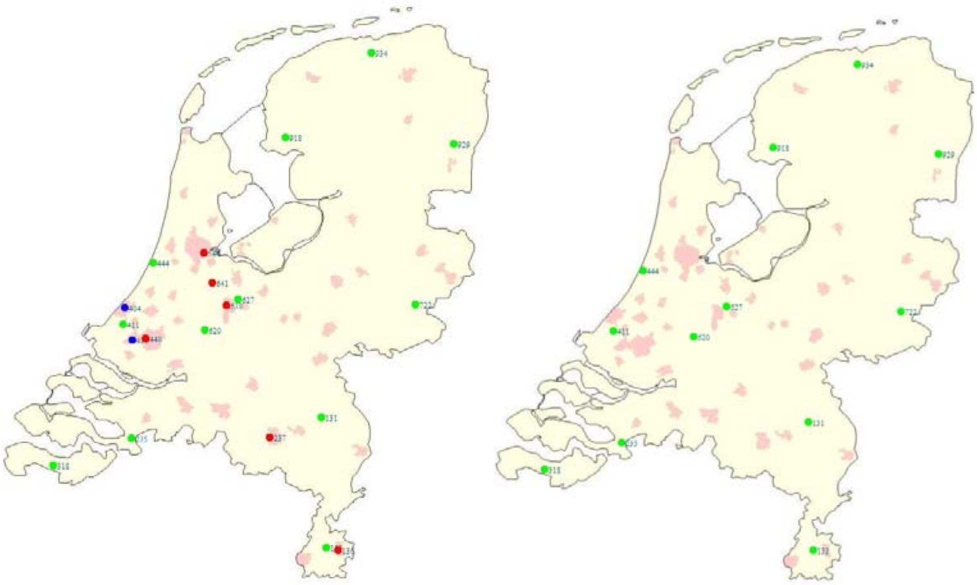

Figure 4 Left panel: all 20 stations of the current SO_2 monitoring configuration. Right panel: the regional background stations in the current SO_2 monitoring configuration.

In the North region, only 1 monitoring station is needed since the concentration of SO_2 in the GCN map is uniform in this area (see Figure 3). Therefore, stations 918 and 929 are removed since station 934 is considered to be the best regional station in the Netherlands. Next, station 411 can be removed since DCMR is monitoring the Rijnmond area in the Netherlands (see Table in Appendix B). Station 620 is preferred above station 627 since the former is considered to become a super-site, i.e. a site where most components are being measured by LML and additional meteorological information is available. In the Southern part of the Netherlands station 133 is preferred above 131 since station 133 is more representative for the province of Limburg. Finally in the Southwest of the Netherlands station 318 is preferred above 235 since the former monitors the

Southwest border of the Netherlands. Figure 5 shows the resulting configuration for the SO_2 monitoring strategy.

A more detailed analysis was performed for the SO_2 monitoring strategy using a calculation tool developed at RIVM. This analysis was performed under the assumption that 10 SO_2 monitoring stations would be placed in LML. Appendix C of this report contains these calculations, which yields similar results as described in this section (see overview & conclusion in C3).

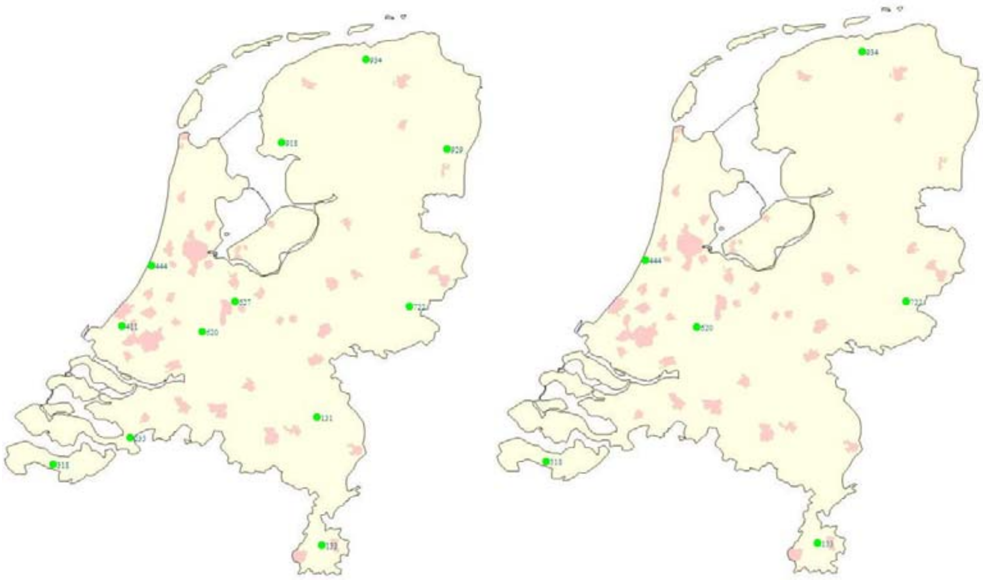

Figure 5 Left panel: all 12 regional stations of the current SO_2 monitoring configuration. Right panel: the selected regional background stations for the current SO_2 monitoring strategy as explained in the main text.

Finally the current proposal includes 1 urban background station from the Dutch National Air Quality Monitoring Network together with 1 industrial site of DCMR, both in the agglomeration Rotterdam/Dordrecht,. In the current SO_2 monitoring network only Vlaardingen (416) is available as an urban background station, hence this station is selected plus an industry station should be selected from the current DCMR stations listed in appendix B. The final proposal for the SO_2 monitoring strategy is depicted in Figure 6.

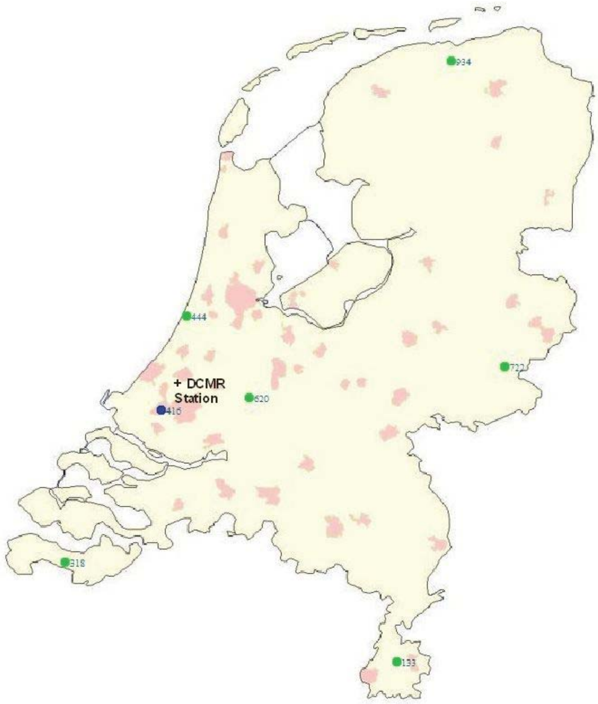

*Figure 6 **Final** proposal for the SO2 monitoring strategy*

5 Conclusions

Mutual consideration between RIVM and VROM has led to the recommendation of the scenario skecthed in section 4 of this report. This SO_2 monitoring network would need to be exploited by a collaboration between RIVM and the DCMR. Table 5 shows the chosen monitoring stations for this SO_2 monitoring network with one urban background station and an industry station in cooperation with the partners of DCMR (selected from the DCMR stations currently in operation, Appendix B).

Table 5 stations for the suggested new SO_2 monitoring network

Station	**Type**	**Operator**
133 Wijnandsrade	Rural	RIVM
318 Philipinne	Rural	RIVM
DCMR station R'dam	Industry	DCMR
416 Vlaardingen	Urban	RIVM
444 De Zilk	Rural	RIVM
620 Cabauw	Rural	RIVM
722 Eibergen	Rural	RIVM
934 Kollumerwaard	Rural	RIVM

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Appendix A Current monitoring stations of SO_2

Table 6 Current monitoring stations of LML (2010)

Station	Type	Area
131 Vredepeel	Rural background	Zuid
133 Wijnandsrade	Rural background	Zuid
136 Heerlen	Traffic	Heerlen
235 Huijbergen	Rural background	Zuid
237 Eindhoven	Traffic	Eindhoven
318 Philipinne	Rural background	Zuid
404 Den Haag	Urban background	The Hague
411 Schipluiden	Rural background	Midden
416 Vlaardingen	Urban background	Rotterdam
444 De Zilk	Rural background	Midden
448 Rotterdam	Traffic	Rotterdam
544 Amsterdam	Traffic	Amsterdam
620 Cabauw	Rural background	Midden
627 Bilthoven	Rural background	Midden
638 Utrecht	Traffic	Utrecht
641 Breukelen	Traffic	Midden
722 Eibergen	Rural background	Midden
918 Balk	Rural background	Noord
929 valthermond	Rural background	Noord
934 Kollumerwaard	Rural background	Noord

Appendix B Monitoring stations at DCMR

Table 7 Locations of DCMR were SO_2 is being monitored. In 2012 most likely the only three stations left are marked in green.

Name station	Location station	Type
MSL	Maassluis-Kwartellaan	Urban Background/Industry
PNS	Pernis-Soetemanweg	Industry (+ ship traffic)
HGV	Hoogvliet-Leemkuil	Urban Background
BOT	Botlek-Oude Maasweg	Industry (+ ship traffic)
SDM	Schiedam-Alphons-Arienstraat	Urban Background
HHB	Hoek van Holland-Berghaven	Industry (+ ship traffic)

Appendix C Preliminary proposals for monitoring strategy

In the process of production and discussion of the monitoring strategies several scenarios with 10 stations were explored. A template has been developed at RIVM to calculate the optimal measuring configuration.

The core of the template consists of objectives which have been formulated. The objectives should be ranked by a weighting factor such that the factors sum up to unity. The objectives which are important for the monitoring strategy of SO_2 are:
- large-scale concentration maps (GCN);
- Acidification;
- Trend determination.

Apart from the objectives mentioned above, the template allows for a separate ranking of weighting factors (typically in between 0 and 100) of which three are important for the monitoring strategy of SO_2: "The Dutch and European Requirements", "Homogeneous distribution over the Netherlands" and "Emphasis on distribution in the middle and southern part of the Netherlands".

As stated above the core of the template are the formulated objectives. Each objective obtains a ranking between zero and unity. Next for each individual objective all stations considered for the measuring strategy are ranked in the following category:
  - not important (0);
  - very low (5);
  - low (10);
  - high (15);
  - very high (20)
  - extremely high (50).

For each objective an expert in the field was consulted to rank the considered stations.

The objective "GCN" differs from the option "Homogeneous distribution over the Netherlands": the latter constructs the *total* number of stations in order to have the most homogeneous distribution over the Netherlands. The GCN objective selects individual stations according to their individual score for their ranking.

A calculation of a measuring strategy starts with selecting those stations which are currently used to monitor SO_2, i.e. N_{start}=20. The other important parameter for the algorithm is the total number of stations, N_{tot}=10 in this case, of which the configuration has to exist. Next the algorithm will calculate which station of the total of N_{start} stations contributes slightest to the total score: this station will be dropped from the list of selected measuring stations, so (N_{start}-1) stations are left. This procedure will be continued until the number of stations left equals the total number of stations required for the network configuration, i.e. N_{tot}.

Four different strategies have been calculated of which the ranking are mentioned in Table 8 below. Each strategy is discussed separately in the sections C.1-C.4. At the end of this appendix Table 9 gives an overview of the selected stations for each monitoring strategy mentioned in Table 8.

Table 8 The different scenarios for the SO_2 monitoring strategy

	Standard	Spread	DCMR	Trend
GCN	0.33	0.33	0.33	0.5
Acidification	0.33	0.33	0.33	0.0
Trend	0.33	0.33	0.33	0.5
Spreading	No	Yes	No	Yes
Middle/South	No	No	Yes	No

C1 Scenario Standard

The scenario divides the ranking of the three most important criteria equally. Furthermore the scenario insures that the configuration of the network fulfils the EU legislation. Figure 7 shows the configuration of the network which is calculated in this way. Most stations are rural background stations except for the two monitoring stations in the agglomeration Rotterdam/Dordrecht, needed to fulfil EU legislation.

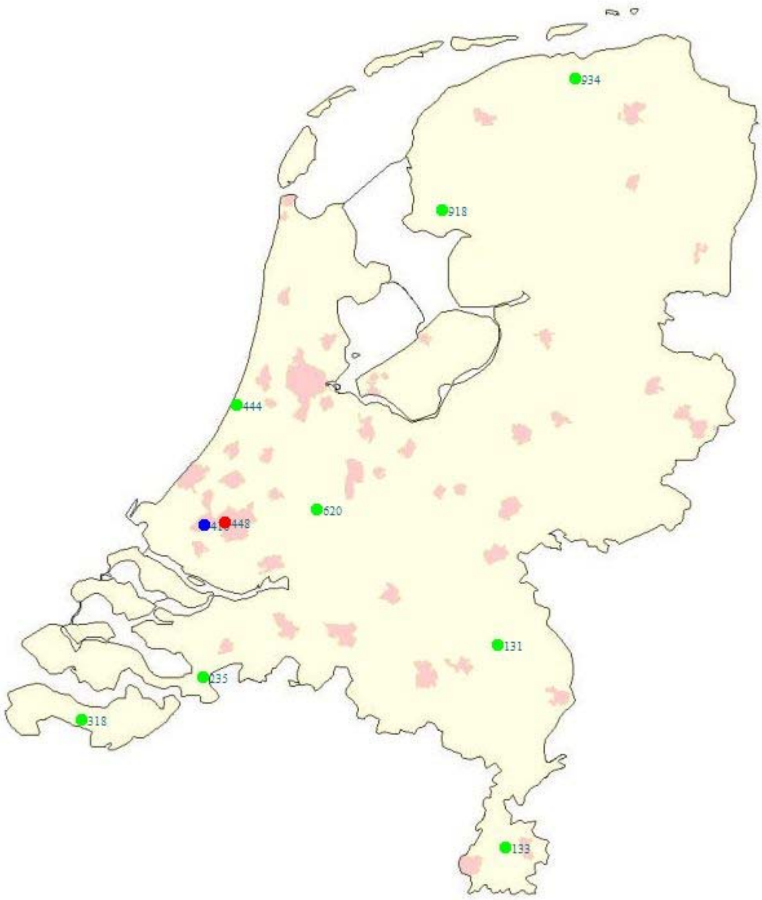

Figure 7 Configuration of Standard-scenario.

C2 Scenario Spread

The scenario divides the ranking of the three most important criteria equally. Furthermore the scenario insures that the configuration of the network fulfils the EU legislation and attributes significance to a homogeneous spreading over the Netherlands. Figure 8 shows the configuration of the network which is calculated in this way. Most stations are rural background stations except for the two monitoring stations in the agglomeration Rotterdam/Dordrecht, needed to fulfil EU legislation. With respect to the previous scenario (scenario Minimum) the station Cabauw (620) has been exchanged for Eibergen (722) which yields a more homogeneous spreading over the Netherlands. An even stronger emphasis on the homogeneous distribution would also replace Kollumerwaard (934) by Valthermond (929). This configuration is not shown!

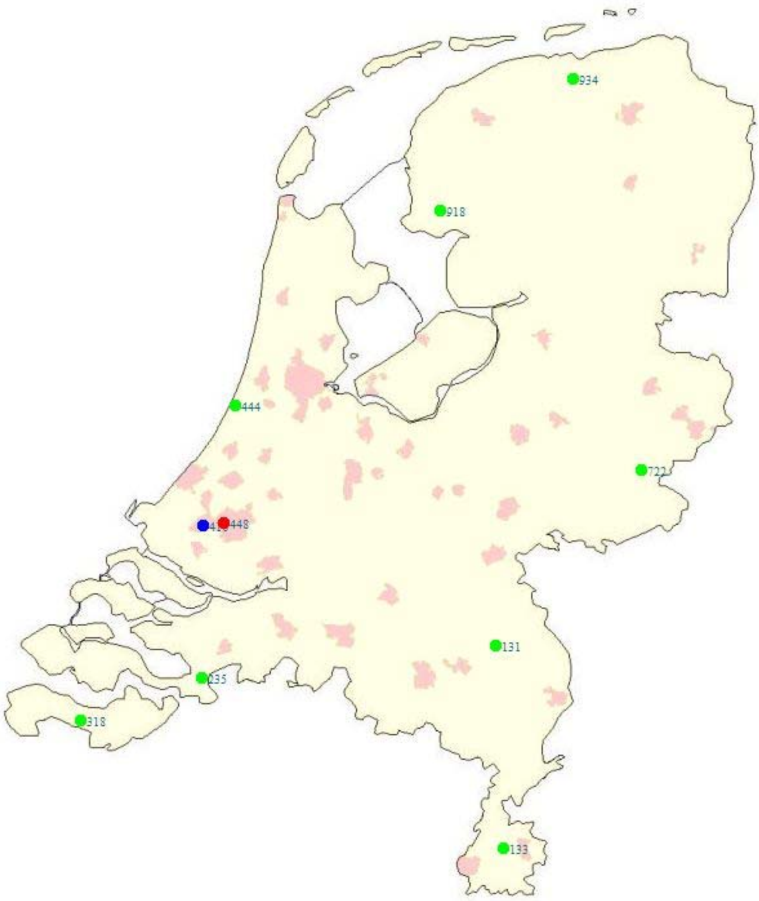

Figure 8 Configuration of Spread scenario.

C3 Scenario DCMR

The scenario divides the ranking of the three most important criteria equally. Furthermore the scenario attributes significance to a relative dense concentration in the middle and southern part of the Netherlands in order to monitor those areas important for acidification. The stations needed for EU legislation in the agglomeration Rotterdam/Dordrecht is now being taken care of by 1 station from DCMR (see appendix B for an overview of DCMR stations) and the urban background station 416 of LML. As a result there are now 8 LML rural background stations distributed over the Netherlands. Figure 9 shows the configuration of the network which is calculated in this way.

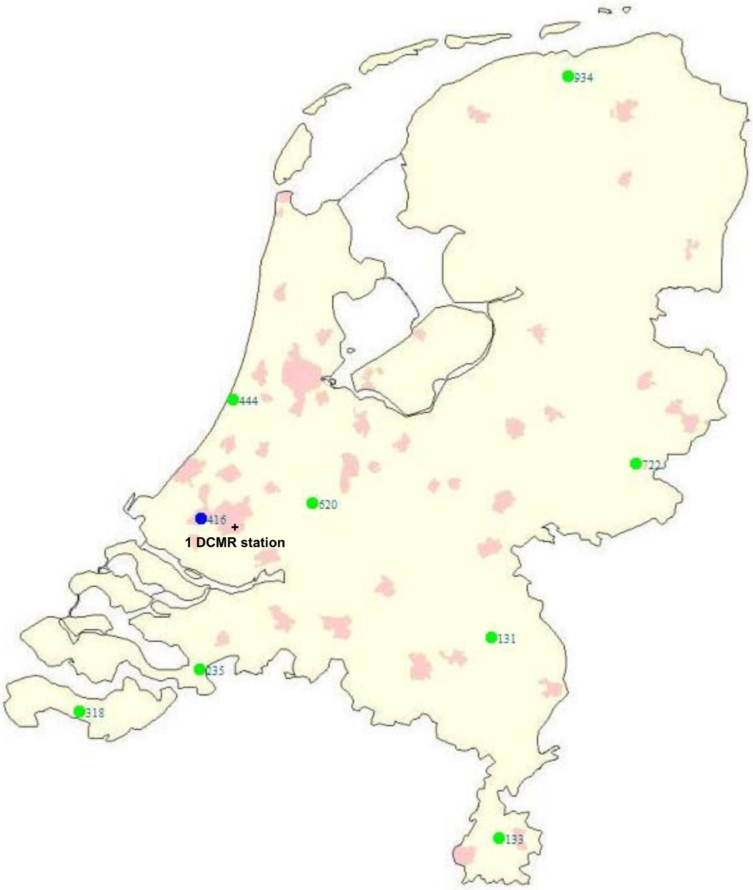

Figure 9 Configuration of DCMR scenario.

C4 Scenario Trend

As a complete alternative this scenario divides the ranking of criteria equally between GCN and Trend. Significance is attributed to a homogeneous spreading over the Netherlands and fulfilment of the EU legislation is taken into account. Figure 10 shows the configuration of the network which is calculated in this way. Most stations are rural background stations except for the two monitoring stations in the agglomeration Rotterdam/Dordrecht, needed to fulfil EU legislation.

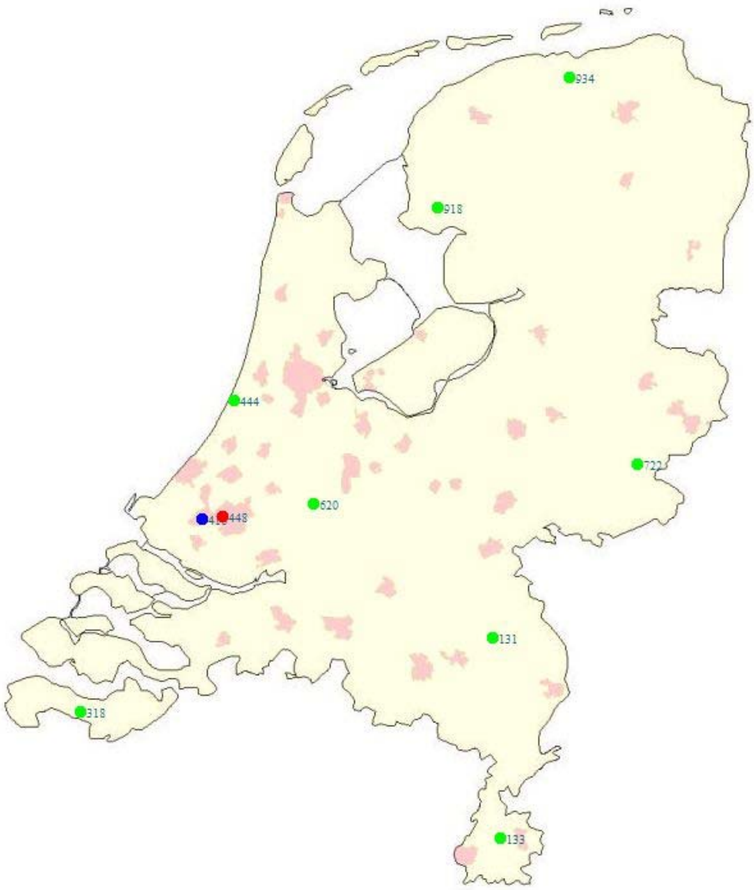

Figure 10 Configuration of Trend scenario.

C5 Conclusions and overview of the preliminary study

Table 9 Overview of the different scenarios

	Standard	Spread	DCMR	Trend
131 Vredepeel	X	X	X	X
133 Wijnandsrade	X	X	X	X
136 Heerlen				
235 Huijbergen	X	X	X	
237 Eindhoven				
318 Philipinne	X	X	X	X
404 Den Haag				
411 Schipluiden				
416 Vlaardingen	X	X	X	X
444 De Zilk	X	X	X	X
448 Rotterdam	X	X		X
544 Amsterdam				
620 Cabauw	X		X	X
627 Bilthoven				
638 Utrecht				
641 Breukelen				
722 Eibergen		X	X	X
918 Balk	X	X		X
929 valthermond				
934 Kollumerwaard	X	X	X	X

The table above gives an overview of the selection of monitoring stations as calculated with the RIVM tool. The yellow shading indicates the 7 monitoring stations which have ultimately been selected in section 4 of this report. It is concluded that there is *good correspondence* between the selection made in section 4 and the selection made with the RIVM tool.

Dit is een uitgave van:

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