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Noise and health in the Greater Rotterdam Area

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In the Greater Rotterdam Area a second study on Noise and Health has been carried out in 2007 and 2008. In 2004 a first study was carried out and in that study it was reported that around 12 per cent of the people living in the Greater Rotterdam Area were highly annoyed by noise mainly caused by traffic. The number of people that were sleep disturbed and suffered from high blood pressure was reported as well and amounted to 6 percent for sleep disturbance and 3 percent was suffering from hypertension.

The 2004 study took place within the regularly framework of the Rotterdam Regional Council of Governments Environmental Monitoring program, a program that reports yearly about the environmental performance indicators in the Greater Rotterdam Area. Beside this yearly report a theme report over the last years is published as well. Last year's theme report was on Air Quality and Energy. In 2007 the board of this program decided that in 2008 the theme should be Noise and Health. The 2008 study is not only an update of the 2004 study but is more detailed and more comprehensive as well and based on recent insights in health effects caused by long lasting noise. This paper comprises only a selection of the 2008 report.

1 Introduction

Speaking about noise monitoring one might think that this paper is going to be about measuring noise in the field. For instance nearby airports, noisy high- or railways or other major noise sources, but in this paper this is not the case. This paper goes into measuring noise indicators that are used to report the subsequent effects of noise. There are a lot of varying indicators which can be used like m^2 of exposed (quiet) area, length of acoustic barriers alongside roads, length of constructed quiet road surfaces, amounts of complaints, et cetera. All sorts of indicators like key performance indicators, process indicators and source indicators are used in the reports about the environmental situation and trends in the Greater Rotterdam Area. In this paper a brief glance will be given in the monitoring method that is carried out in the Greater Rotterdam Area.

The Greater Rotterdam Area also called the Rijnmond region (which is the Rhine delta) is the region around the city of Rotterdam and its harbour. Within the Greater Rotterdam Area 18 municipalities are situated. DCMR EPA carries out the environmental tasks for these 18 municipalities (including the city of Rotterdam) but also for the province of South Holland in this region. In this region about 1.2 million people are living and more than 20.000 enterprises are active, varying from a bakery or a butcher to giant refineries and chemical industries such as the Dutch Anglo enterprise Royal Shell.. A lot of transhipment of containers and minerals take place in the Rotterdam harbour. The Rotterdam harbour is the largest harbour in Europe and one of the largest in the world. DCMR EPA noise section works on noise caused by industry, road and rail traffic, airports, recreational activities, music, dance and sports events, building and construction works. More about the noise section can be found at DCMR EPA's website www.dcmr.nl . More about the harbour of Rotterdam can be found at www.portofrotterdam.com

Since 1994 the provincial and local authorities in the Rotterdam area had already realised that joint monitoring of the regional environmental situation was essential to an effective environmental policy. Since then, fourteen so called monitoring reports on the Greater Rotterdam Area have been published. In the early years the environmental quality appeared to improve visibly. More recently, however, on balance no further progress has been made. The explanation for this is that in the nineties, the 'easy' environmental problems could be solved through stringent source policy; the initiative at that time lay with the major polluters. As a consequence of this the difficult problems remained. Problems which were mostly caused by diffuse sources. For example noise nuisance is caused, among other things, by road and air traffic, and industry, while shipping traffic and road traffic are important sources of air pollution. Since there are usually a number of authorities responsible for tackling these diffuse sources, effective cooperation between these authorities is a prerequisite.

Thus within the framework of drafting monitoring reports (briefly called MSR), the most important authorities in the Greater Rotterdam Area environmental field are represented. By jointly sketching an integral picture of the environmental situation in the region these authorities can also jointly take those measures which are necessary in order to tackle the diffuse sources. The Rijnmond Regional Air Quality Action Programme is a good example of this. Special attention is devoted to road and shipping traffic, and private households, as well as to industry.

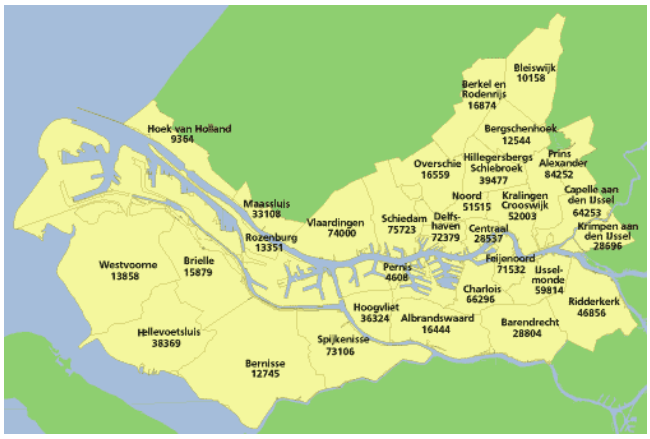

Figure 1: Greater Rotterdam Area

The goal of MSR is twofold. In the first place MSR aims at tracking the progress of environmental policy in the region and indicating new developments relating to environmental quality, free from value judgements. In this way MSR contributes to the policy cycles of the authorities that work together in MSR. Administrators and their staff thus obtain information which enables them to place, evaluate and, if necessary, adjust their policies in a broader context. On the basis of this information they can also formulate new policy or speed up its implementation. Where no verifiable policy objectives are available, indicators in any case perform a warning function so that timely adjustments are still

possible. In the second place, MSR informs residents and the business sector about the state of the environment in the Rotterdam region and its recent developments. In this way MSR fulfils the obligation that authorities have, in the framework of the Århus treaty, to supply environmental information to their residents. Furthermore, MSR responds to the societal need for transparent government.

This paper only goes into the noise indicators that were reported over the past years. Special attention will be given to the reports of 2008. This paper gives also a brief comparison between three Dutch cities on noise related health effects.

2 Noise indicators

The first MSR reports (2000 till 2004) comprised a lot of information about noise. Because the acoustic zoning of industrial areas had just been finished a lot of information was available to report. Reported was the number of noise complaints that was registered by the Central Monitoring Room of the DCMR EPA. Separate as well consolidated noise map with the noise contours of the noise of industry, roads, railways and airports together were reported. The result of a survey among the citizens of the Greater Rotterdam Area that compared the annoyance caused by noise, feelings of unsafely, stench and particulate matter was reported as well.

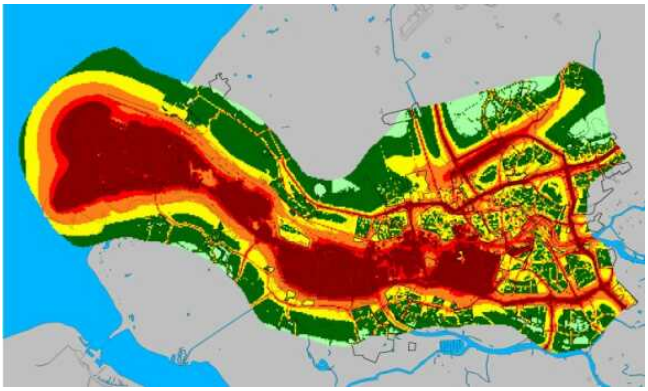

Figure 2: Combined Noise Map Greater Rotterdam Area

The Noise maps showed us that there was hardly a quiet place in the Rotterdam area to be found. The whole area was covered by a blanket of noise. The most important source was road traffic noise and this would increase more and more if mitigations stayed behind. From 1996 sanitation programs on traffic noise, industrial noise and railway noise were started. Till now only the sanitation on industrial noise has been finalized. The other sanitation programs are still going on. The sanitation on traffic noise is planned to end in 2020.

The noise indicators that are currently used in the Greater Rotterdam Area are the total number of complaints, but the number of complaints per noise sort as well (traffic noise, railway noise, airport noise et cetera), number of exposed people, number of exposed houses, natural areas with noise levels lower than 40 dB(A), number of allowances for building houses or other vulnerable objects with a high noise burden

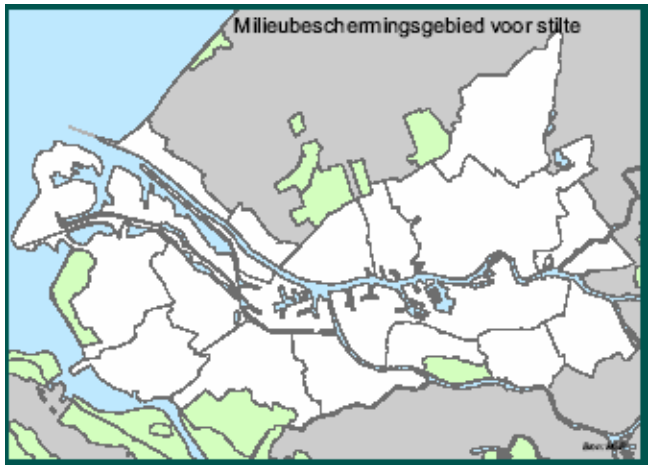

Figure 3: Quiet areas in the greater Rotterdam Area < 40 dB(A)

The preferable noise limit amounts 50 dB and the maximum limit for constructing houses amounts, according to the Dutch Noise Act, 55 dB but in some special circumstances housing can be realised in areas with a higher noise load.

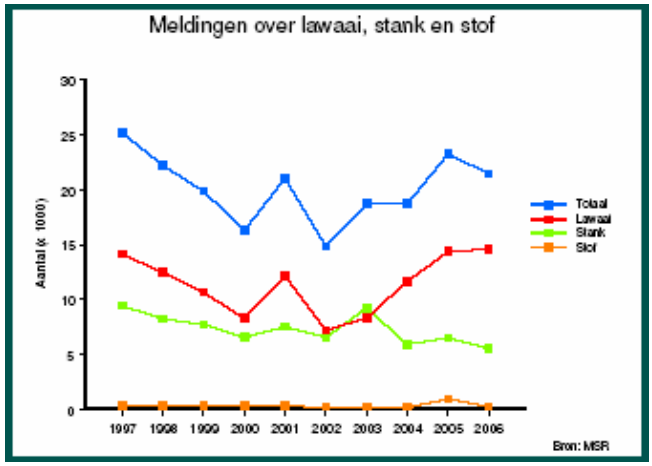

Figure 4: Complaints noise(lawaai), stench(stank) and dust(stof)

From 2004 the numbers of annoyed and highly annoyed people were used as a noise indicator and the number of people suffering from hypertension and sleep disturbance as well. Notwithstanding these noise indicators the MSR organization is always looking for more appropriate indicators to affect citizens, politicians and policies and other stakeholders. This because the decibel (dB) is not understood by the public and the politicians. They cannot imagine what 50 dB implies. Therefore the MSR organization looked for other descriptors like health effects and economical effects.

Health effects of long lasting noise in the Greater |Rotterdam Area were reported for the first time in 2004 and economical effects were reported for the first time in 2006. These reports were based on rough information about the noise exposure and the number of noise exposed houses. In 2008 more detailed information became available because in the Greater Rotterdam Area 10 municipalities, including the city of Rotterdam, have noise maps according to the END 2002/49/EC. All those 10 municipalities are situated within an agglomeration as meant in the END.

Figure 5: Traffic Noise Map Rotterdam 2007

For the 2008 survey these noise maps were used and for those cities that were not enforced to draft a noise map according to the noise directive 2002/49/EC additional noise calculations have been made by the Noise Section of DCMR EPA. With this information new more accurate numbers of exposed houses were calculated by the DCMR EPA.. As usual in urbanized areas traffic noise is the most dominant noise source and therefore responsible for most health effects in the Greater Rotterdam Area.

3 The 2008 Survey on Noise

3.1 Actors and methods

The calculation of the noise contours was mainly done by the Noise Section of DCMR EPA. The counting of houses and other sensitive objects was done by this section as well. This information was delivered to the Rotterdam Health Service. The Rotterdam Health Service estimated the number of annoyed, highly annoyed, sleep disturbed people and the number of people that suffer from hypertension. They have done the estimations on DALY's (Disabled Adjusted Life Years). Expressed in an easier way one could say the DALY is the only quantitative indicator of burden of disease that reflects the total amount of healthy life lost to all causes, whether from premature mortality or from some degree of disability during a period of time.
Beside representatives of the MSR team, the survey was guided by a temporary working group which existed of the Noise Section of DCMR EPA, the Rotterdam Health Service, the Amsterdam Health Service, the province of South Holland and the Dutch National Institute for Health and Environment (RIVM).

Estimating the annoyed and highly annoyed people the so called "Miedema curves" have been used. The estimation of people that are sleep disturbed was based on the Miedema curves as well. The formulas are known and officially recognized on an international level as well and can be found in literature (Miedema 2003). Estimations to determine the number of people that were suffering from hypertension (high blood pressure) and myocardial infarct were done with the so called PAR approach. Determination of the number of deaths was done by the method which is given in literature (Kempen 2005/Knol 2005). MSR has passed over the scientific discussions about hypertension originated by traffic noise and taken it for granted. To estimate the amount of myocardial infarctions the Babisch (2006) findings were used, see table 1.

Average Sound Pressure level during the day (6-22 h) [dB(A)]	Relative risk OR
<=60	1
>60 - 65	1,05
>66 - 70	1,09
>70 - 75	1,19
>75 - 80	1,47

Table 1: Risk Myocardial Infarction Traffic Noise (Babisch 2006)

It must be noticed that during the study done in 2004 a cumulated noise map was used to estimate the subsequent health effects. In the 2008 study separate noise maps for traffic noise, industrial noise, railway noise and airport noise were used as enforced by the END. This hampers a good comparison between both studies.

3.2 Health effects Greater Rotterdam

As mentioned before using the noise maps data gives a better thus more accurate number of houses. This will mean that all calculations done on annoyance, high annoyance et cetera result in more accurate figures. All differences found can be explained by this phenomenon.

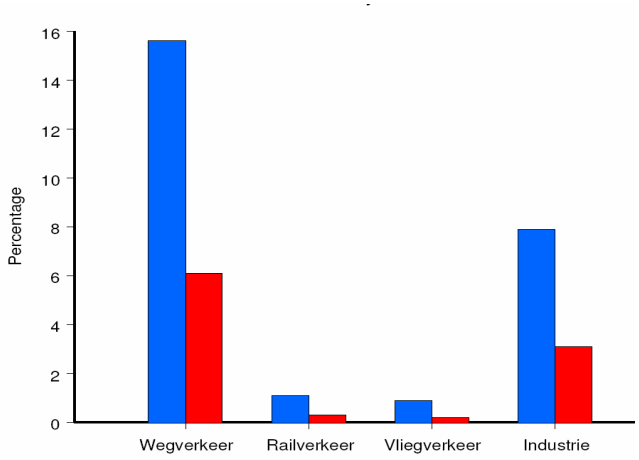

Figure 6: Annoyed and Highly Annoyed people in Greater Rotterdam Area for respectively road traffic noise, railway noise, airport noise and industrial noise

Within this study the percentage of annoyed and highly annoyed people has been estimated on calculations (according to Miedema) and on the other hand based on a questionnaire that was set out in 2005. It's widely known that the outcomes of calculated effects often are lower than the outcomes based on questionnaires. In figure 6 the results of the annoyed and highly annoyed people based on calculations is presented. In figure 7 the national numbers are given based on questionnaires done by Franssen (2004).

The percentage of the calculated annoyed (A) and the highly annoyed (HA) that was found in this study was compared to the Dutch situation. In the Netherlands approximately 4 per cent is highly annoyed because of traffic noise and in the Greater Rotterdam Area we found approximately 16 per cent. Compared with the outcomes of 2004 we see a predictable difference. The number of annoyed and highly annoyed people has decreased. This is mainly caused by the more accurate numbers of houses due to the more detailed calculations

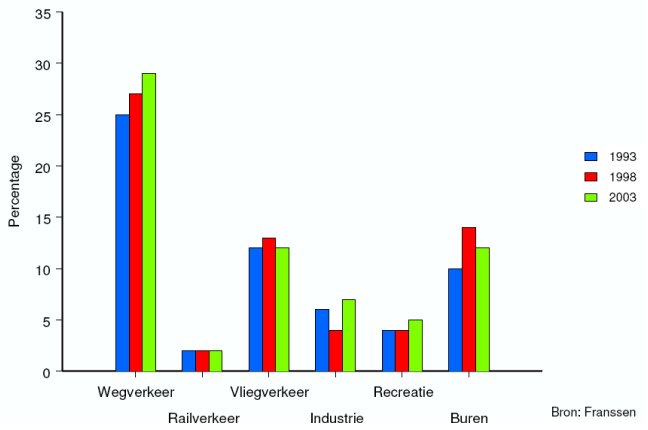

Figure 7: Annoyed and highly annoyed people in the Netherlands for respectively road,rail,air, industry, recreation and neighbour noise

Looking to the sleep disturbed people in the Greater Rotterdam Area it's found that about 7 per cent is sleep disturbed and 3 per cent severe sleep disturbed by traffic noise. These figures are based on calculations. Using the questionnaire outcomes we can notice a remarkable difference; the percentage for sleep disturbance amounts to almost 15 per cent!

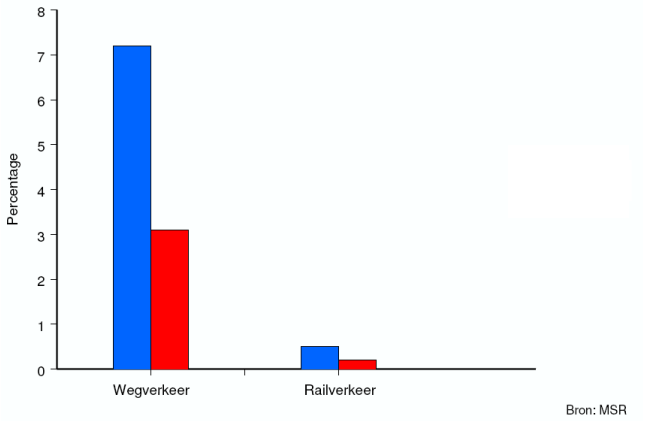

Figure 8: Percentage Highly Annoyed people in the Greater Rotterdam Area for respectively traffic and railway noise (acc. to Miedema curves).

According to scientific studies there is enough evidence between long lasting exposure to traffic noise and getting a myocardial infarction. It's not amazing that some of those people that were hit by this immediately or on short or long term will die. Notwithstanding that most results point in the direction that such a relation is present still discussions are going on about the relation between long lasting traffic noise and hypertension. In a number of cases hypertension could lead to hart infarctions and strokes and subsequently to death. In the Greater Rotterdam area we took these discussions for granted and we estimated the numbers of people that are suffering from hypertension and people that die because of long lasting traffic noise. The numbers of people that suffer from hypertension are some thousands and some tens of people dies per annum.

The number of DALY's per 100.000 inhabitants in the Greater Rotterdam Area was calculated as well. For traffic noise the number of DALY's amounts more than 120 per 100.000 inhabitants. Compared to the national situation this is rather high because on national level a number of 165 DALY's occurs for traffic noise versus 185 in the Greater Rotterdam Area. The total amount of DALY's in The Greater Rotterdam Area amounts 260 per 100.000 inhabitants.

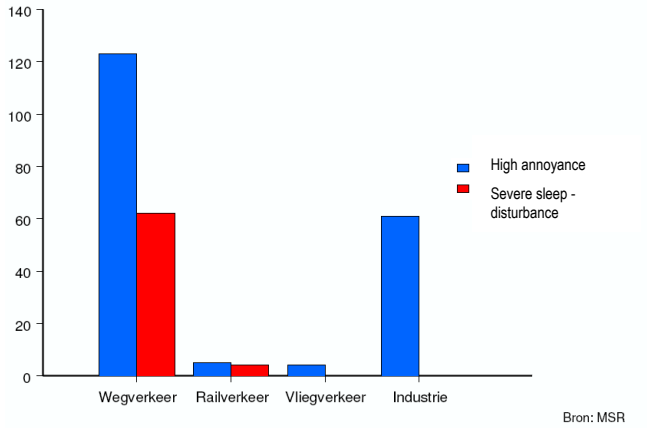

Figure 9: Numbers of DALY's in the Greater Rotterdam Area for respectively road, railway, airport and industrial noise

3.3 Comparison between Dutch towns

Besides reporting the situation in the Greater Rotterdam Area it was decided to compare the four largest cities (Amsterdam, Rotterdam, The Hague and Utrecht) in the Netherlands. Unfortunately the data of the noise map of the city of The Hague wasn't sufficient so it became a comparison between the three largest cities in the Netherlands. The team that was working on this study decided to make an additional report about the comparison between the four cities later in 2008. Comparing the figures of the comparison, see figure 10, there are similar outcomes. The figures do not differ a lot.

	Percentage inhabitants (20 years and older)		
	ROTTERDAM	AMSTERDAM	UTRECHT
Road			
Annoyed	19,1	17,2	18,5
Highly Anoyed	7,9	7,2	7,4
Rail			
Annoyed	1,8	1,8	3,7
Highly Anoyed	0,4	0,5	1,0
Airport			
Annoyed	0,7	4,5	-
Highly Anoyed	0,2	1,5	-
Industry			
Annoyed	9,7	-	-
Highly Anoyed	4,0	-	-

Table 2: annoyed and highly annoyed in 3 Dutch cities

Within the boundaries of Amsterdam and Utrecht there are hardly enterprises and Rotterdam has a lot of enterprises

(more than 23.000). The city of Utrecht does not have an airport. These facts are the reason that a comparison on these two noise sorts is not reported in the table. The higher number of annoyed people caused by railway noise in Utrecht is obvious because Utrecht is the national railway interchange of the Netherlands.

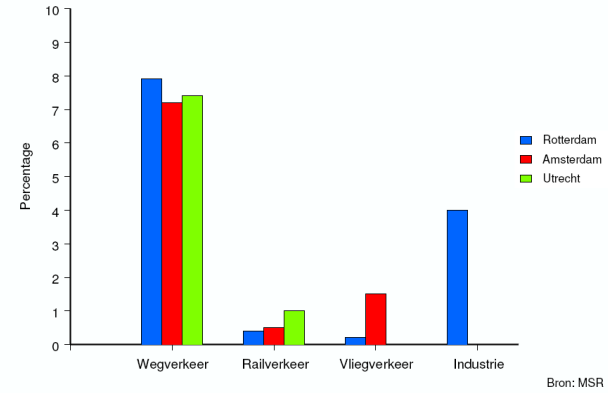

Figure 10: number of highly annoyed people in three Dutch cities for respectively road, rail, airport and industrial noise

A comparison of DALY's was made as well between the three cities. This is shown in table 3 and figure 11. Because the data of Amsterdam on sleep disturbance was not sufficient no calculations have been made. A comparison of the remaining cities in the Dutch situation is given in figure 11. The figure shows that in Utrecht – per 100.000 inhabitants – there is more sleep disturbance than in Rotterdam or in the whole of the Netherlands. This is mainly caused by railway noise.

	ROTTERDAM	AMSTERDAM	UTRECHT
High annoyed			
Road	715	881	284
Railway	39	59	38
Airport	16	177	-
Industry	364	-	-
Severe sleep disturbed			
Road	363	-	164
Railway	27	-	23

Table 3: Calculated DALY's in 3 Dutch cities

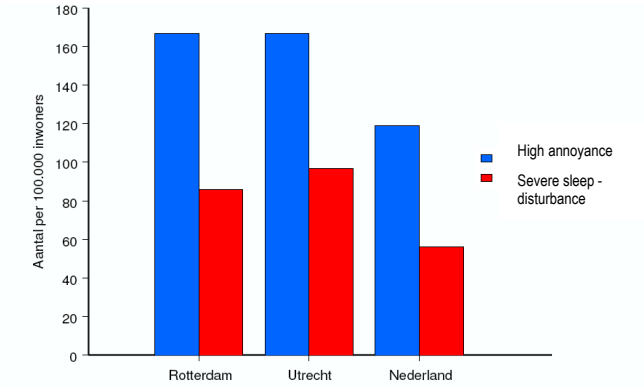

Figure 11: DALY's Rotterdam, Utrecht and Netherlands

5 Conclusions

In the Greater Rotterdam Area a high number of annoyed, highly annoyed people is present. 19 per cent of the people is exposed to 60 dB or more. The percentage for the Netherlands as a whole amounts 8 per cent. Based on dose response curves the results show that about 8 per cent of the people living in the Greater Rotterdam Area are sleep disturbed and 3 per cent of them even severe sleep disturbed. A survey done with a questionnaire show a percentage of 15 per cent sleep disturbed people. The same phenomenon is visible with the annoyed and highly annoyed people. Based on dose-response curves it can be concluded that around 7 per cent is annoyed and 3 per cent highly annoyed but based on questionnaire it's found that the number of highly annoyed people amounts approximately 12 per cent. A explanation for the found differences will be lacking in this paper. Thousands of people are suffering from hypertension and some tens of people are dying because of long lasting noise. Those figures are a minimum because it's known that these methods result in an underestimation. As aforementioned there is a remarkable difference in outcomes based on calculations combined with dose response relations and outcomes based on questionnaires.

Acknowledgments

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