Noise and health in the greater Rotterdam area

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INTRODUCTION

As from 1994 the provincial and local authorities in the Rotterdam Metropolitan Area already realized that joint monitoring of the regional environmental situation was essential to an effective environmental policy. Since then, fifteen so called MSR reports on the Rotterdam region 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 policies; the initiative at that time lay with the major polluters, mainly industries. As a consequence of this the difficult problems remained, 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 MSR the most important authorities in the Rotterdam region environmental field are represented. By jointly sketching an integral picture of the environmental situation in the region, in MSR, these authorities can also jointly take those measures which are necessary in order to tackle the diffuse sources.

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 judgments. In this way MSR contributes to the policy cycles of the authorities who work together in MSR. Administrators and their staff thus obtain information which enables them to place, evaluate and, if necessary, adjust their policy in a broader context. Based on 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 Aarhus treaty, to supply environmental information to their residents. Furthermore, MSR responds to the societal need for transparent government.

The last MSR report was published mid-2010. During more than 15 years the monitoring program and report were elaborated. At first, only environmental themes as noise, air- and soil pollution were reported and developments on environmental permitting and enforcement of these permits. The very last report comprises indicators on energy, sustainable mobility, waste, water, air quality, noise, external safety, green and nature, space and also health. Environmental themes are cross border issues with other policy fields like economy, green, spatial- and urban planning, mobility et cetera. This is in particular true for noise. The number of noise indicators has increased during the past years. This paper mainly goes into the surveys that were done in 2008, the Environmental Perception Survey (Van Vliet et al. 2008) van con-

ducted in 2007[1] and the Rotterdam Noise Map as meant in article 7 of the END (European Noise Directive 2002) and some underlying reports as the MSR report on Noise, Health and Money (Van Wijk et al. 2008).

NOISE IN THE ROTTERDAM METROPOLITAN AREA

From earlier surveys, the so called Deltaplan Noise (Maat et al. 2000) and the CBA 2nd Maasvlakte (Eijgenraam et al. 2001) which was conducted by DCMR, commissioned by the CBS[2], it was found that the Rotterdam Metropolitan Region encounters a lot of noise from industrial premises, roads, railways and aviation. This was established by the consolidated noise map that was produced based on the four separated noise maps for the END, see Figure 1.

Figure 1: Consolidated Noise Map Rotterdam 2008

In the Rotterdam Metropolitan Area, which harbors the largest port of Europe and the third in the world, many noise sources are present. The region comprises more than 22,000 enterprises, 350 km's of motorways, 250 trunk roads, 250 local roads and 100 km's of railways. The region is very crowded, around 1.2 million citizens are living in this region and 400,000 laborers are working in the harbor, the factories, offices et cetera. At this time, the city of Rotterdam has 560,000 inhabitants and is the second largest city of The Netherlands. The Rotterdam Metropolitan Region contributes approximately 13 % of the Dutch Gross Domestic Product. A small business airport is situated north of Rotterdam, which causes a lot of complaints.

NOISE, HEALTH AND MONEY

Within the MSR program, it is more or less a custom to produce a special theme report, besides the overall report on all components. In 2008 a theme report on noise has been drafted and published. Besides indicators on money a lot of noise indicators were reported like number and percentage of inhabitants exposed per noise class and per type of noise, annoyed and highly annoyed people, people that encounter sleep disturbance, severe sleep disturbance and even the so called DALY's. The graphs and tables within the theme report are based on the findings of the Rotterdam Noise Map. Beside the map on traffic noise, industrial noise, railway noise

[1] Reported in 2008

[2] CBS is the Dutch Bureau for Statistics

and aviation noise, the consolidated noise map was produced and a map with potential quiet areas as well. A few of these findings are depicted below.

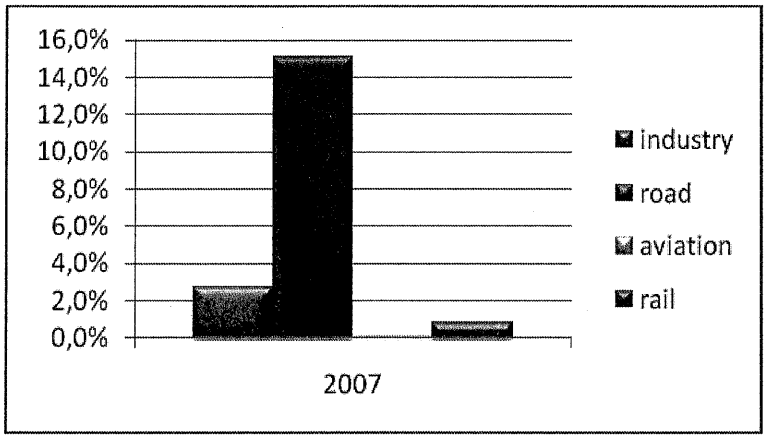

Figure 2: Percentage of annoyed people

The Figure shows that road traffic noise is by far the most troublesome noise. This is plausible that road traffic noise affects the most people in Rotterdam. The number of exposed people by road traffic noise amounts almost 18,000. The Figure of the exposed people stays behind in this paper but can be found at the website of MSR, www.hetmilieuinderegiorotterdam.nl.

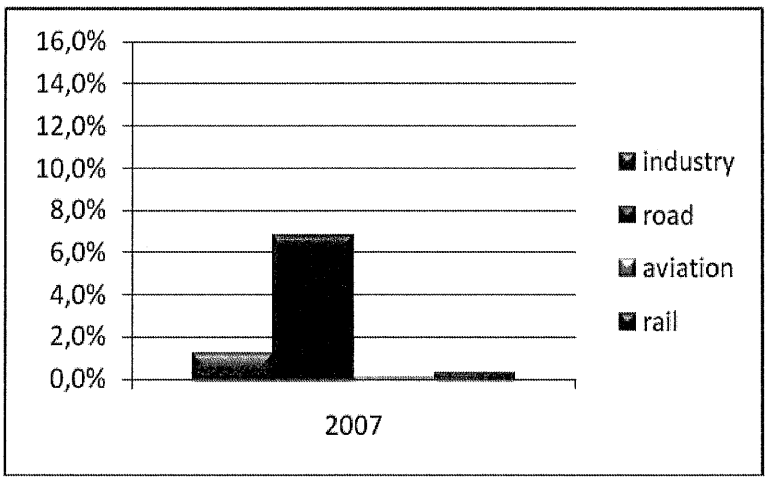

Figure 3: Percentage of highly annoyed people

The same applies for highly annoyed people. About 7 % of the 'Rotterdammers' are subject to high annoyance. It looks that industrial noise and railway noise hardly do not play a role. Although, expressed in real numbers, there are almost 20,000 citizens exposed to noise that is annoying and around 8,000 citizens to noise that result in high annoyance. The number of people that is exposed to aviation noise (from the Rotterdam Airport) is rather low (198 versus 64 for annoyance and high annoyance).

The report on Health and Money memorizes also the number of DALY's due to road traffic noise and industrial noise. This is given in Table 1.

It is also stated in the report that noise, especially long lasting noise caused irreversible health effects in men like high blood pressure, cardiovascular diseases like heart attacks and strokes which could be fatal. It is estimated that the number of fatalities,

due to long lasting noise, in the Rotterdam Metropolitan Region amounts to 35-40 per annum.

Table 1: Disabled adjusted life years

Rotterdam and the DALY's	
High annoyance	
Road traffic	715
Rail traffic	39
Aviation	16
Industry	364
Severe Sleep Disturbance	
Road traffic	363
Rail traffic	27

ENVIRONMENTAL PERCEPTION SURVEY

Every two years this survey is conducted by the province of South Holland for the whole province which includes also the Rotterdam Metropolitan Region. In this paper, the results for noise are subject to a further analysis. The survey is done by telephone and partly by the Internet. As from 2005 the so called ICBEN scale has been used. In the previous years, a 5-point scale was used. In the comparisons made in the survey report a conversion has been made to transpose the 5-point scale into a 11-point scale. Some of the findings of the EPS are depicted below. The survey conducted in 2007 is reported in 2008.

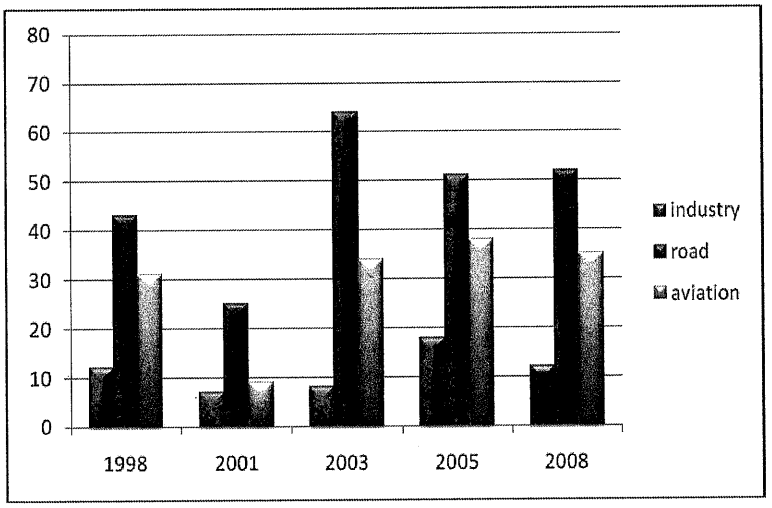

Figure 4: Percentage of annoyed people (ESP)

In the perception of the 'Rotterdammers' road traffic noise is by far the most annoying followed by aviation noise. Industrial noise is ranked at the third place. Railway noise is not included in the EPS unfortunately. It is striking to see that the perception of the citizens is varying from year to year. Only in the case of aviation there is a reason for the drop in 2001. In that year, the class 2 airplanes have been phased out. The variation found in road and industrial noise cannot be explained so far.

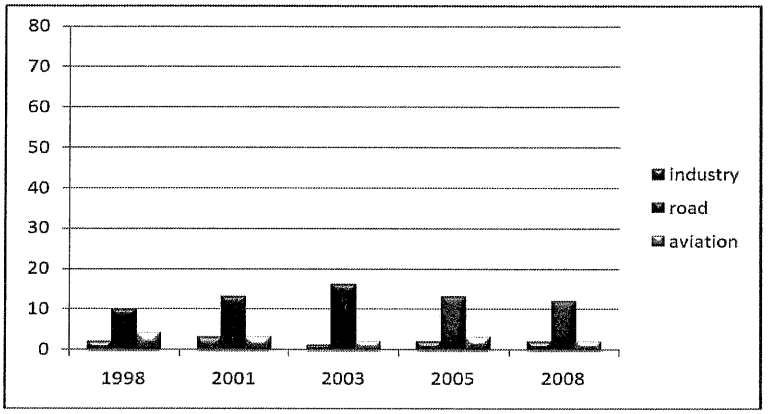

Figure 5: Percentage highly annoyed people (EPS)

NOISE COMPLAINTS

The registration room for incidents and complaints of DCMR EPA has registered noise complaints since 1973 when DCMR EPA was founded. Noise and stench complaints are the most complaints submitted by the citizens. A lot of the complaints are about aviation. The last year complaints from bars, cafés and discos are increasing. Despite all kinds of measures like phasing out chapter 2 planes, sanitation of industrial and road traffic noise, the trend is going up. Only aviation noise goes slightly down the last three years.

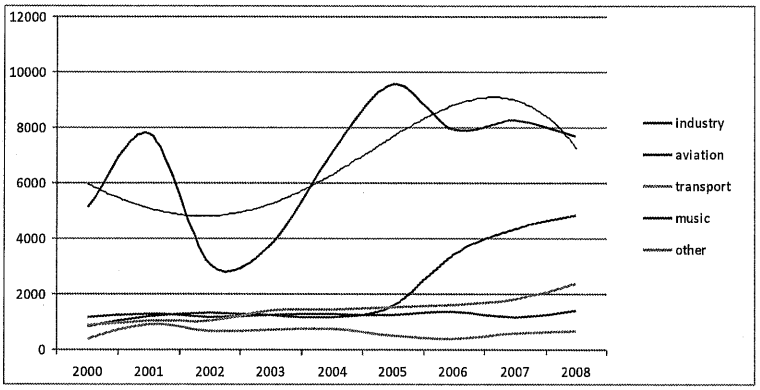

Figure 6: Noise complaints (2000-2008)

It is widely known that there is no direct relation between the number of complaints and the perceived noise in terms of annoyance, sleep disturbance, etc. Non-acoustic factors are also playing an important role at noise levels lower than 65-70 dB L_{day}. Noise complaints on aviation noise are strongly influenced by a few complainers. Around 10 % of the complainers have submitted 75 % of the complaints!

COMPARISONS

As recommend by the WHO noise levels above 55 dB L_{den} should be avoided because as from this point high annoyance occurs in human. A map was made in order to show the extent of houses and sensitive objects[3] in the Rotterdam municipality that are exposed to noise higher than 55 dB L_{DEN}. A part of this map is depicted in Figure 7.

[3] like schools, hospitals, nursing homes, et cetera

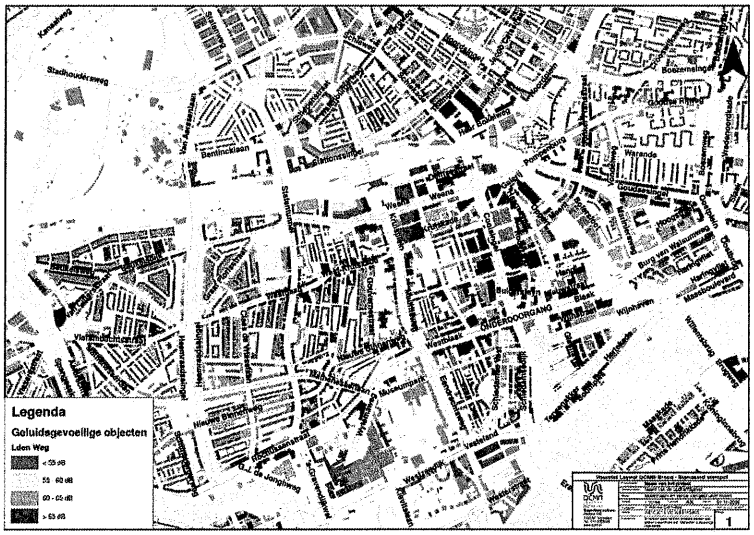

Figure 7: Houses exposed > 55 dB L_{DEN}

Due to the high expenses of measures and the impracticality of them, it was decided to use a higher threshold of 63 dB. For the night, a similar map was made. The threshold value according to the WHO recommendations amounts 40 dB L_{night}. As in many cities the L_{night} seems to be a forgotten parameter. The map with the houses that are exposed to 40 dB L_{night} and higher is depicted in Figure 8.

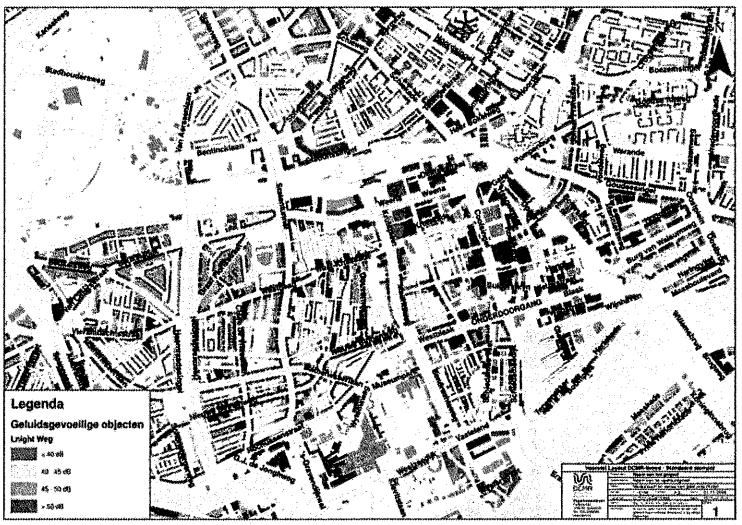

Figure 8: Houses exposed to >40 dB L_{night}

As 40 dB is the interim value recommend by the WHO and 35 dB the preferred limit value on the long term, it can be noticed that a lot of houses and sensitive objects cannot comply with these limit values and that measures will be needed in a drastically way. It can be doubted if the preferred noise limits are feasible because effects of local measures are limited. (Wolfert 2009).

A comparison was made for the estimated and the reported annoyance and high annoyance for the year 2007/2008.

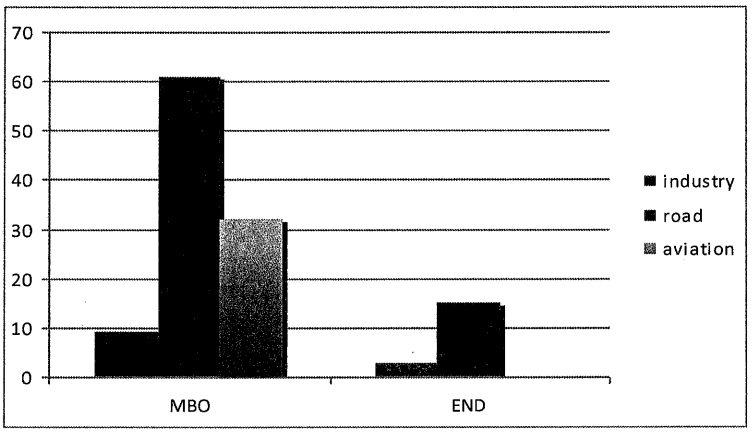

Figure 1: Annoyed people EPS versus END

The figure shows that there is a remarkable difference between the annoyance reported in the EPS and the annoyance estimated on the noise map according to the END. In the EPS the scores are 4 times higher than estimated with the noise maps results using the Miedema dose-response curves. Aviation noise hardly does not have estimated annoyance (0.03) because it assumed that L_{DEN} is not a proper metric for aviation noise to express annoyance or high annoyance for this type of small airports. People refer annoyance to the 'over flights' peak levels and number of over flights and not on a yearly based averaged.

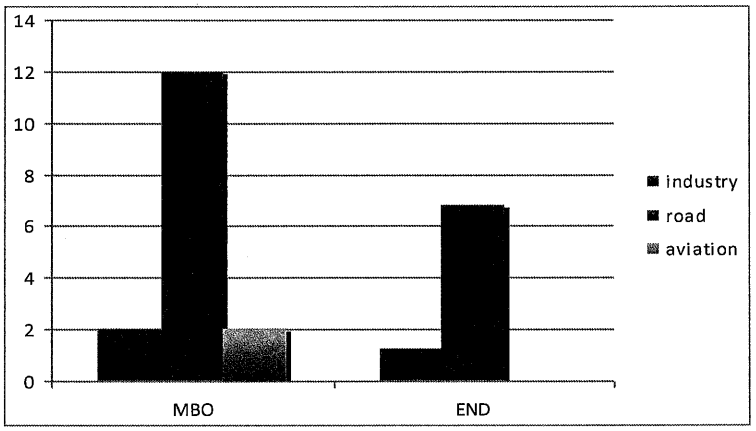

Figure 10: Highly annoyed people EPS versus END

For highly annoyed the difference is less than for annoyance, notwithstanding there is about a factor 2 between EPS and END findings. Knowing that field surveys certainly do not exactly match with estimations based on noise maps numerous reasons can be reported, among them:

1. Inaccuracy of the noise calculations due to the modeling, the validity of the method at given distances in the Rotterdam Metropolitan Region (>700 m), assumptions, missing data et cetera, which could give an underestimation.
2. Local circumstances in Rotterdam could have an important influence. Compared to other cities, Rotterdam has a high percentage people with a low income and a high percentage of members from another ethnic entity (± 50 %). Especially the group originated from non-western countries are assumed less sensitive to noise because it was found that they hardly

complain about noise (DCMR EPA, 1997). Due to this, one should expect that a reverse view should occur.

3. Noise levels are assessed as from 50 dB while it is known that annoyance occurs as from 42 dB L_{DEN} and sleep disturbance from 35 dB. A huge number of people exposed to noise levels between 42 dB and 50 dB are excluded because the noise map only shows the noise levels above 50 dB L_{DEN} and L_{NIGHT}. This gives an underestimation as well.
4. The samples made (number of people interviewed) in the EPS amount (472) which is about 0.08 % which could be too low. Within the 95% Confidence Interval an error range of ± 4.5 % is estimated in the report.
5. The questions in the EPS questionnaire let some room for interpretation and could be improved. Example: it is not clear if mopeds, scooters are included in the questions and they are included in the calculations! From survey done before it is known that mopeds and scooters in cities are perceived as very annoying (Sandberg 2002).
6. Non-acoustic factors possibly could have influenced the reported perception in the EPS (Findell & Stallen 2009), especially the people classified as annoyed.
7. Applying the Miedema curves at a smaller -local- scale introduces inaccuracies because dose-response relations for traffic noise and annoyance appear to be scale-specific: relationships established at international levels sometimes deviate from national relationships; in turn these relations can deviate from regional ones. For policies this means that consideration should be given to the limitations and transferability of (inter-) national exposure-response relationships used in local situations (Breugelmans et al. 2007).
8. Although, the Miedema curves might be the best we currently have, it is widely known that there is still some room for improvement. A few things should be improved:
    a. The study used the so called cut-off points (45 dB and 75 dB); from other studies (not noise) it known that this could influence the results. A sensitivity analysis could raise some insight if other cut-off points, e.g. as from 35 dB will deliver other results.
    b. Those curves are partly based on old data (1970-1980); since then lifestyle has drastically changed in the western world. It could be considered to exclude the old data and to add recent data in order to estimate updated curves. In some of the older surveys only the percentage of highly annoyed was estimated and some surveys comprised limited data for high noise levels originated by rail and road traffic which should be an extra reason to skip those data (Giering 2010).
    c. The Miedema curves are also based on data from other continents, like North America and Australia. Culture and habits differ from the 'European culture' if there is a European culture. Cities, especially city centers in Europe differ from cities in North America, these are rather new and have structures, which are more car friendly. It is known that car use in North America is more common than in Europe. E.g. more than 75 % of the Canadians goes every day by car, in the 8 major agglomer-

ations is somewhat lower (± 68 %, 2006). In Australia it is almost the same (Australian Bureau of Statistics). In EU27 car use is lower.

d. The conversion from L_{DN} to L_{DEN} includes a number of assumptions which could influence the findings; is the conversion applicable to highways and smaller roads in cities both, where no continuous flow of traffic appears?
e. The conversion of the 3 or 5 points scale to the 11-points ICBEN scale has introduced some inaccuracies because of the questions that differed in the distinguished surveys and it is assumed that offering people a more detailed scale a more balanced input will obtained.

CONCLUSIONS

From Figures 4 and 5 can be concluded that human perception on noise is not a stable factor but more like the stock markets. It can vary from year to year. Reasons could be incidents that have been occurred, media attention, spatial developments near district, et cetera.

Outcomes of 'calculated noise effects' differ remarkably from those that were found during field surveys like the EPS. Some divergence could be expected taking into account the scattering of data points and the 95 % confidence level. Significant divergence can be addressed to numerous causes, see above.

For politicians and policy makers those discrepancies are confusing and do not contribute to better understanding of the noise and the noise.

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