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EU-Noise Maps: analysis of submitted data and comments

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ABSTRACT

Nearly all EU member states have submitted noise map data as required by EU Directive 2002/49. All the submitted data was published on the EU-web site, which makes it possible to compile and analyze the data.
As could be expected, not all data was usable as published. Even when the EU-data format was used (which most did), confusion could arise on the figures. After scrutiny, data for 64 million people was obtained with respect to road traffic noise in agglomeration, and for significant lower part of the population for the other noise sources. This is 53% of the data to be reported, and 13% of the EU27 population.
Apart from some unexpected glitches, the overall impression is that the quality of the data is fair and yields important information on the exposure of the EU-population to noise. The rough estimates from the Greenpaper on Noise[1] from 1996 are largely confirmed.

1. INTRODUCTION

The Environmental Noise Directive[2] (2002/49/EC, further to be addressed as END) asks the EU Member States to prepare noise maps and action plans for a limited number of agglomerations (those with more than 250.000 inhabitants), major roads (over 6 million vehicles per year), major rail (more than 60.000 trains per year) and major airports (more than 50.000 aircraft movements).

The purpose of the END is stated in the considerations as *to provide a basis for developing and completing the existing set of Community measures concerning noise emitted by the major sources, (..) and for developing additional measures, in the short, medium and long term*, while according to article 1 the aim is extended to *define a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to exposure of environmental noise.* To this end, the END continues, the exposure will be assessed by common methods, the results will be made public, and action plans must be made. The first round of maps was to be submitted to the Commission before 30 July 2007, and only a few Member States (MS's for short) succeeded in doing so. However, by the end of 2008 nearly all MS's (with the exception of Malta and Bulgaria) submitted at least something. In the next paragraphs the method of data collection is explained, and subsequently through analysis of the data the following questions are tried to be answered:

- What is the overall quality of the data in terms of coverage, reliability, comparability ?
- What conclusions can be drawn from the exposure data?

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- What recommendations can be derived for the second round of noise mapping in 2012 for which preparations are already starting?

2. DATA COLLECTION

From the CIRCA reporting website[3] all the files were downloaded. Some files were also obtained from the EIONET data repository[4] and a few isolated cases are based on published data on the internet. Additional data on population densities was obtained from Eurostat. Although the bulk of the material was available by December 2008, updates and some new files continued to arrive up to mid June 2009. These were not all taken into account for the analysis, but it was checked that the conclusions (or even the percentages) didn't change.
Luckily most MS's used the standard reporting format. From those who didn't the data could be extracted after careful reading of the reports.
Data collection was limited to the following items:

- Lden and Lnight values road traffic noise in agglomerations
- Lden values railway noise in agglomerations
- Lden values of industry in agglomerations
- Lden values of major roads
- Lden values of major railways
- Lden and Lnight values of major airports

The data was then transferred to an internet based spreadsheet[5], allowing to distribute and discuss the data between noise experts.

3. ANALYSIS

A. Data Quality

In the first round reports were expected on 120 million EU inhabitants in the agglomerations. By mid 2009 the data of 87 million people (72%) were reported. This is "only" 17% of the total EU population of 497 million, but by any other standard an impressive effort without precedence. The reporting discipline differed widely. While a number of countries reported exactly what was asked, unfortunately data were very incomplete for a number of countries. This included large and small countries, "old" as well as "new" MS's. This of course makes it more difficult to generalize outcomes to the entire EU.
A major nuisance when extracting the reported data is section 1.5 of Annex VI of the END (Data to be sent to the Commission) which starts with *The estimated number of people (in hundreds)….* Oblivious to the fact that the second phrase in the same section explains that this means that the figures should be *rounded* to the nearest 100, and even gives the example that 5200 means that the real figure could be between 5150 and 5249, quite a few authorities report the number in units of hundreds. Not always it is obvious what the real number is, and sometimes a guess had to be made. If an agglomeration chooses to calculate only the main oads, low figues may be mistaken as rounded ones, leading to considerable distortion. Especially in the case of major roads and major railways it had to be assumed that at least the reporters would be consistent over the noise sources. In one case inspection of the reported luchily short stretches) major roads on Google Maps was necessary to establish the order of magnitude.
Another source of error is incompleteness of the data. Many MS's report exactly what they were supposed to, but others are so incomplete that the remaining data is almost useless. The real question is however what the data say on a particular MS.

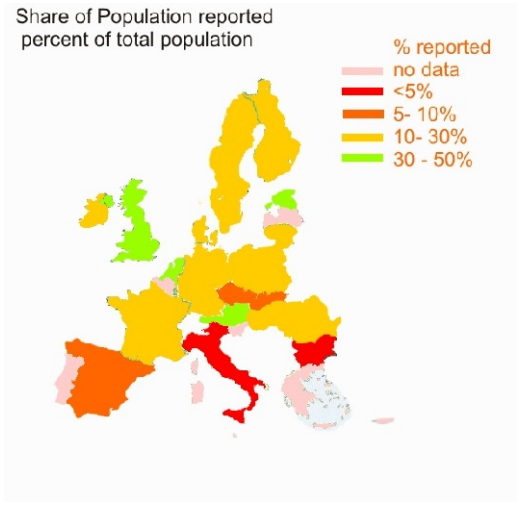

figure 1.Percentage reported of total

Therefore the percentage of the entire population for which noise data is reported is calculated (figure 1). This is based on the road traffic data (agglomerations + major roads). All the people in the agglomeration are counted, while only the exposed > 55 Lden for major roads are counted. This assumes that the population resulting below 55 Lden in agglomerations is *reported* (and calculated) as such, which not always needs to be the reality. These figures are slightly underestimated because the other noise sources are not taken into consideration. Because of the much smaller numbers (see below) and some overlap, this can safely be neglected.

There are some more countries that are listed as "no data" than the 2 mentioned in the introduction. Where Malta submitted no data whatsoever, the other no data countries gave at least some information (usually on airports).

Generally the coverage is acceptable, with a good distribution over North/South and East/West.

The second step is to have a close look on the exposure data. To this end the distribution of exposure over noise classes where prepared per agglomeration. The results are represented in figures 2 and 3, countries grouped according to region.

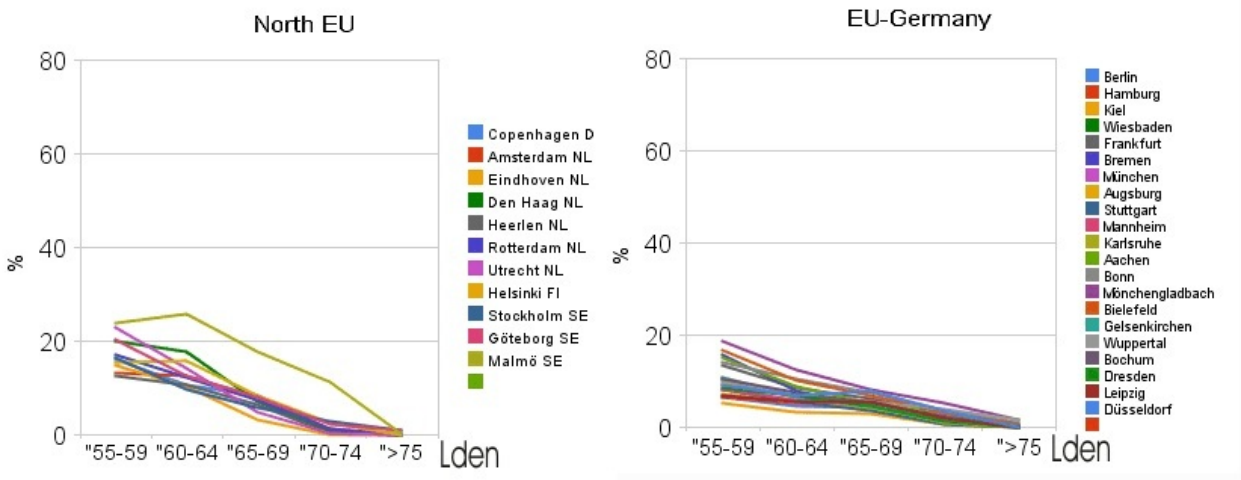

figure 2. Distribution of inhabitants over noise classes in Northern EU en Germany

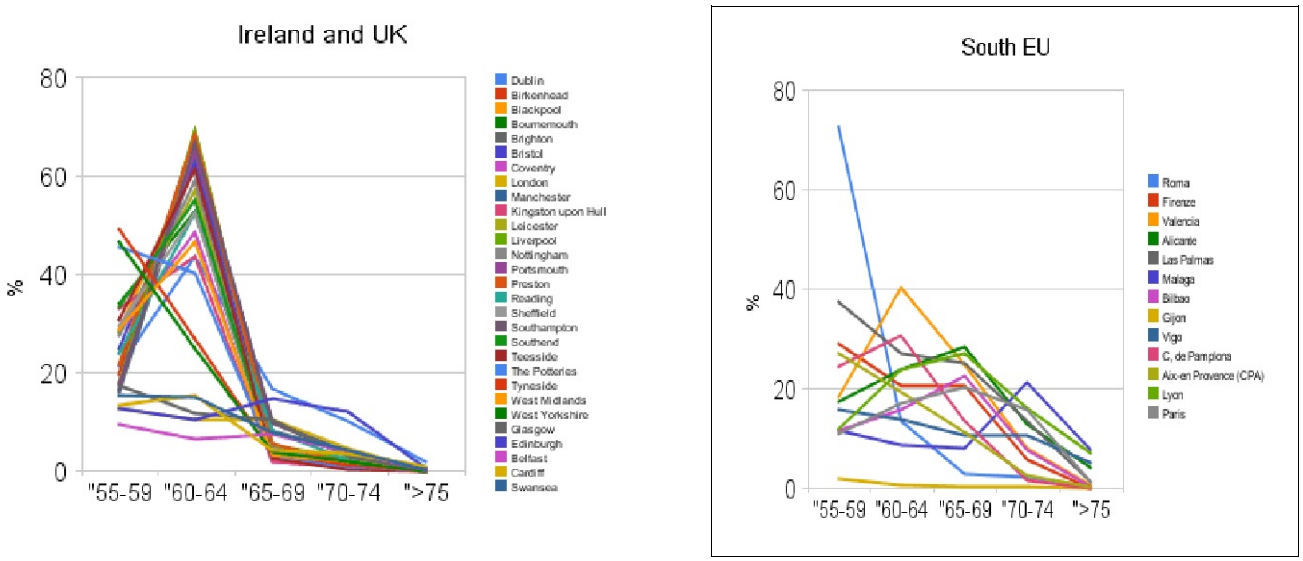

Figure 3. Distribution of inhabitants over noise levels, UK and Southern EU countries

The difference between UK-agglomerations and the others is striking: almost all inhabitants fall in the exposure category between 60 and 64 dB. As this outcome is counter-intuitive and different from almost all other EU-cities, experts were consulted which hinted at the input data as the major cause. Model calculations showed that if for residential streets where no data was available a relatively high traffic density is assumed (as is the case in the UK approach), the effect could very well be a peak in the 60-64 noise band.
This peak is visible for some other cities too: data show that percentages of this exposure band raise exponentially with inhabitants over 55 dB. This fact is essentially due to a – presumably estimated- high traffic density as for UK approach.

It seems that that cities with high percentages of exposure > 55 Lden also have an high ratio of 60-64 over 55-59. This could be
related to how the modelling has been done: ones which considered only major
roads also inside agglomeration usually obtain an underestimation of people exposure in quieter areas (due to ignoring local low traffic roads) so this people are usually reported in lower bands obtaining a ratio lower than one; ones which considered all roads reasonably obtain a ratio greater than one because buildings near streets have high levels and only few buildings are screened so that they have levels under 60 dB. Moreover this relationship is confirmed by Lnight data: we couldn't see directly a

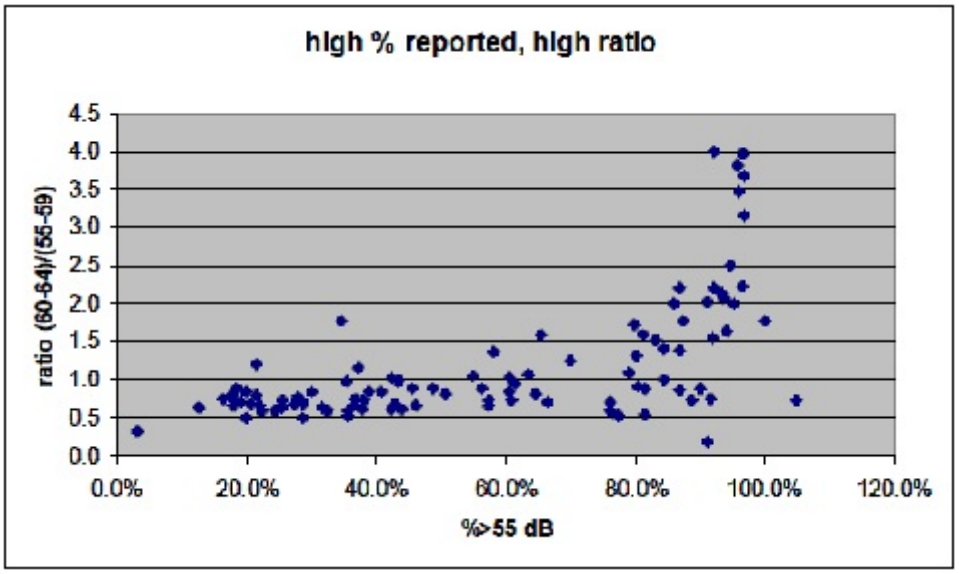

Figure 4. Ratio of Lden classes 60-64/55-59

comparison with previous graph because we need to translate about 10dB lower and we haven't data of lower bands.
The absolute levels of the exposure depend to some extent on the calculation methods. Unfortunately the requirement of the END (art 6.2) to demonstrate equivalency between national methods and the interim methods has not been met. The analyses carried out by JRC indicate that the differences for simple situations are not dramatic. In a relatively large number of cases the interim methods have been used, especially in MS's who did not have a particular noise policy. In this first analysis the influence of calculation method has not been studied in any systematic way.

B. Levels of exposure-road traffic

In how far the data correspond to "reality" cannot be inferred from the data. Apart from obvious input errors (like the UK – case) there are a number of factors that do influence the exposure. These are for example:

- emission strength; eg the car fleet in Eastern Europe may be noisier than the Western states
- Density: high density may lead to higher exposure due to shorter distances and higher traffic volumes
- Public transport: in areas with good public transport part of the noise emission is shifted to other modes (and perhaps overall production is less)

Having little information on differences due to methodical factors we can only look at the data as it is, and assuming that the modelling isn't the main cause of differences.
The range of exposures is huge: Leaving out obvious errors like Spanish Gijon (3% over 55 Lden) and Las Palmas de Gran Canaria (105%) the lowest reliable figure is Stuttgart (18%) and highest Bratislava with 100%. Selecting the capital cities, the noisiest are Bratislava, Dublin, Rome and Prague, while Tallin, and Berlin are definitely quiet - see figure 4. The same pattern can be seen in Lnight values. In general countries in the north-west seem to be less noisy then those in the south-east. That fits with common sense. Although this couldn't be proven, there seems to be some support for the thesis that cities with excellent public transport (a dense net of subway and tramlines) have a relatively low exposure for road traffic noise – see Berlin, London, Amsterdam, Copenhagen.

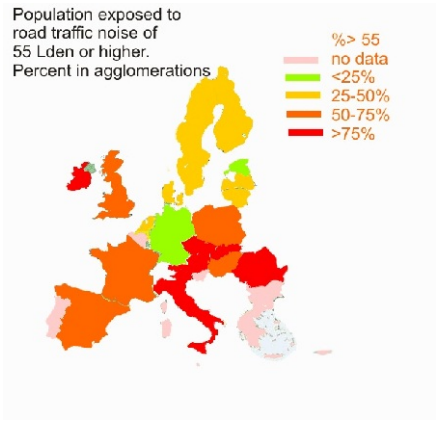

Figure 5. Exposure MS

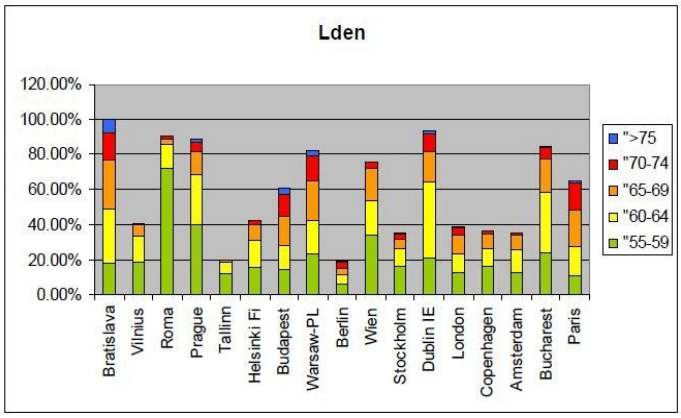

Figure 6. Exposure to road traffic in EU capital cities

The latter 2 have by the way a higher than average bicycle transport. On the other hand: Paris and Vienna have excellent public transport, but still a high number of exposed. The topic clearly needs further study.
A surprising high number of people is exposed to noise from major roads. Whereas 49 million people are exposes in agglomerations, an additional 20 million are exposed to noise from 82.576 km major roads. This a small fraction from all roads. Half of this comes from the UK!

C. Levels of exposure- railway noise

Railway noise shows less variation, although some outliers warrant further study. In general even cities with a generous railway system (like Utrecht and Berlin) remain below 10% exposed to levels over 55, figure 6 shows that Katowyce and Bratislava have very high levels. This could perhaps be attributed to a definition problem. Probably in Katowyce the extended tram system (207 km) is counted as railway, while in Berlin it appears that only the Bundesbahn tracks are calculated as railways, and the extensive light rail system as streetcar. And of course the subways do not show.

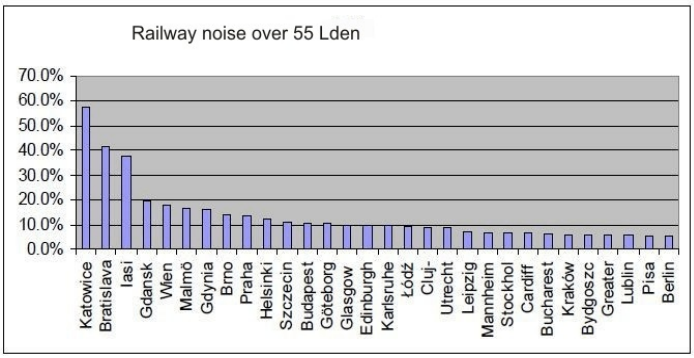

Figure 7. Exposure to railway noise

Along the major railways a substantial part is exposed to levels over 55 Lden, around 3.8 million people. There is a large variation in the number of exposed per km of track. This ranges from 4 in Finland (no surprise here) up to 864 in France. There seems to be no connection with population density: high density Netherlands reaches 309/km In total 7.6 million are reported to levels of railway noise over 55 Lden, 50/50 in agglomerations and along major railways.

D. Levels of exposure - industrial noise

Only few cities report substantial exposure to industrial noise over 55 Lden. Austria states that in the entire country there are no exposures over 55 Lden. The remaining agglomerations report exposures far below 1%. In total 686.000 inhabitants were reported to have exposures over 55 Lden.

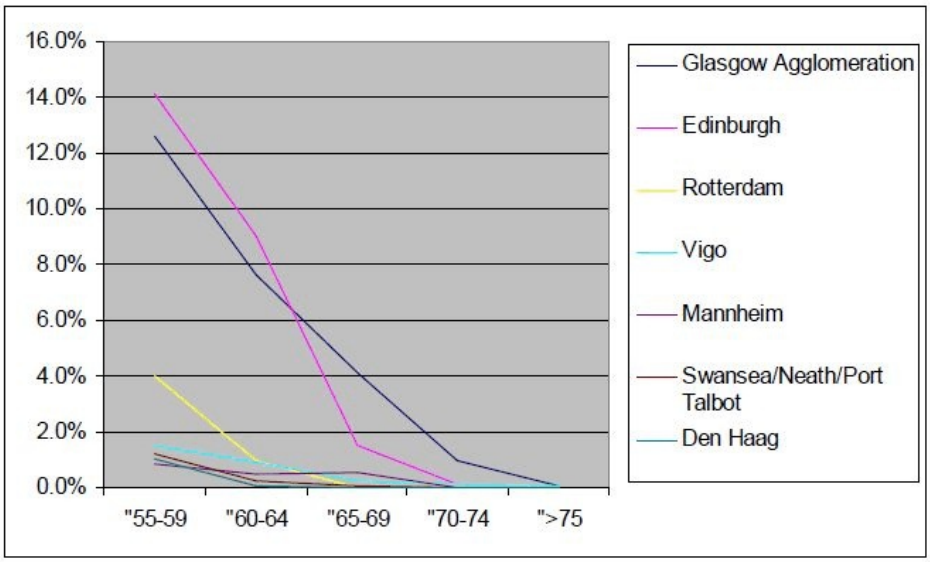

Figure 8. Exposure to industrial noise

E. Levels of exposure - airport noise

The 80 or so major airports in the EU were responsible for 2.5 million inhabitants over 55 Lden, perhaps lower than expected judging from the attention this topic gets in the press. The results are similar to those from the study carried out in 2003 by DG-Tren[6]. There are however large individual differences between the assessments when looking at individual airports.

The percentage of people exposed to high levels of aircraft is low compared to other sources. Only 7% of those exposed to >55 Lden are exposed to levels over 65 Lden (this is 20-30% for road and rail noise).

There is no obvious connection between airport characteristics and exposure. Frankfurt and London cause between them nearly 50% of all the exposure. Leaving those aside, in the top 10 largest airports (> 250.000 aircraft movements/year) exposures range from a mere 344 inhabitants (Rome) up to 125.000 (Brussels, Paris). The exposed surface per movement (this could be an indication of the fleet composition; a lower value indicates a quieter aircraft fleet) ranges from 1135 m2 / movement (Budapest) down to 43 m2 for the Danish Roskilde. Perhaps in Budapest the military aircraft are included in the calculation. The other large airports score relatively high; Frankfurt and London Heathrow (665 and 519) again in the top 10. This is probably connected to their high share of intercontinental traffic. That there is room for improvement can be deducted for the relatively low footprints from hubs like Amsterdam(430) and Rome (421).

F. Levels of exposure – comparison of sources

As expected, road traffic is the major source, followed by railway, aircraft and industry.

Table 1. Number of inhabitants exposed to noise from different sources (millions)

	Road traffic in agglomerations	Major roads	Railway in agglomeration	Major rail	Aircraft noise in agglomeration	Major airports	Industry
> 55 Lden	49.5	20.5	3.7	3.8	1.4	1.8	0.6
> 65 Lden	14.5	4.1	0.8	0.9			0.09
> 50 Lnight	213						

This amounts to a total of 80 million over 55 Lden and 19 million over 65 Lden. In terms of health impact and of cost these are very large numbers. Although extrapolation to the entire EU is difficult because a lot of data is missing (and where they are missing there is a bias to high-exposed areas) the fact that the data only reflects 17% of the population means that these figures can easily double. The distribution between sources is less likely to change: in the agglomerations 57% is due to road traffic, 6% to railways, 1% to industrial noise and also ~1% to aircraft noise. Outside agglomerations a large number of people are exposed to major roads, railways and airports.

3. DISCUSSION

Notwithstanding considerable difficulties in analysing and evaluating the data, the overall impression is that the data provide a satisfactory insight in the noise situation in the EU. Which is not very comforting: even without extrapolating, more than 80 million people are exposed to levels that cause a daily nuisance, while 20 million over 65 (over 55 Lnight, the WHO-"warning level") may see their health seriously impaired – also because of a raised risk on sleep disturbance. Extrapolations from the few countries where a nationwide mapping has been carried out (Austria, Netherlands, Norway) show that these figures could easily double, so they come close to the figures that were already "questimated" in the Greenpaper on Noise in 1996 (170 million between 55 and 65 dB-Lday).
The data show also there is still a lot to be desired in terms of precision and harmonisation. Although this leads to a large confidence interval, it is the authors opinion that will not lead to a different assessment of the noise situation. It is however important to get a more precise estimate especially for the purpose of monitoring progress of noise reduction measures like quiet vehicles/trassport modes and quite tyres.

4. CONCLUSIONS AND RECOMMENDATIONS

The huge effort to map European noise exposure is leading to a better understanding of the extent of noise exposures. Road traffic is the largest source of noise, followed by railway noise, aircraft noise and industrial noise. The major infrastructure causes relatively large numbers outside agglomerations to be exposed.
The mapping process needs to be improved on the following aspects:
- harmonisation of reporting formats to avoid ambiguities and facilitate analysis.
- harmonisation of calculation methods (including input data).

As it may take considerable time to develop this data stream into a monitoring system, a separate system for EU noise monitoring should be developed.

ACKNOWLEDGMENTS

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