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THE DUTCH NATIONAL NOISE MONITORING NETWORK: 10 YEAR OF MONITORING AND FUTURE INNOVATIONS

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ABSTRACT

The Dutch National Institute for Public Health and the Environment (RIVM) operates the National Noise Monitoring Network. This network consists of 44 measurement locations alongside motorways and 36 measurement locations near railways. Since 2013, we have used this network to validate the yearly reported noise production levels calculated by the Dutch road and railway authorities. In addition to this validation, the measurements are also used to assess the performance of the Dutch environmental noise calculation method. When necessary, the calculation method is adjusted. The long-time measurements are currently performed with simple dataloggers. These dataloggers were cheap and innovative at the time of installation but are now end-of-life. Besides, the dataloggers have limited recording memory and a limited power supply. The logging interval is low and data retrieval is done physically every two months. With the development of a new system, we will elevate the overall possibilities of the network. An important aspect is remote data retrieval. A challenge is that these loggers must be able to be placed in publicly accessible locations with an independent power supply. This paper will address the results of 10 years of monitoring and further highlight the improvements of the network by the new system.

Keywords: *Noise monitoring, long-term noise measurements, innovative measurements*

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1. INTRODUCTION

As of 2013, the Dutch National Institute of Public Health and the Environment (RIVM) operates the National Noise Monitoring Network throughout the Netherlands, thereby monitoring the noise production from motorways and railways. In the Netherlands, the noise production from motorways and railways has a legal maximum. Each year, the road and railway authorities have to report the produced noise over the last year. Previously set maximum levels cannot be exceeded: when close to exceedance, measures have to be considered to make sure noise levels will be reduced to and remain below the maximum. RIVM is assigned as the independent institute to validate the yearly reported noise productions by the road and railway authorities. Where the road and railway authorities report calculated noise productions, RIVM validates these with measured noise productions.

The measurements of the National Noise Monitoring Network are also used to assess aspects of the Dutch environmental noise calculation method. This calculation method is administrated by RIVM. It plays an important role in the execution of the Environment and Planning Act of The Netherlands. Space is scarce in the Netherlands, and the division of this scarce space between infrastructure, buildings, industry, and a healthy living environment highly depends on calculations of environmental parameters, such as noise.

The National Noise Monitoring Network started with simple inexpensive class 2 dataloggers. A robust measurement protocol led to a steady 10-year data record. However, with advancing technologies we will now improve and upgrade this noise monitoring network.

2. NATIONAL NOISE MONITORING NETWORK

The Dutch National Noise Monitoring Network consists of 44 measurement locations alongside motorways and 36 measurement locations alongside railways [1]. All measurement locations are close to reference points at which the road and railway authorities calculate the noise production. These virtual reference points are situated 50 meters from the road or railway, 100 meters apart and at an altitude of 4 meters. A simplified calculation model (no buildings and except for roads absorbing ground) is used to calculate annual average noise levels during the day, evening, and night (L_{den}) at these reference points. Measurement locations are chosen strategically to cover the diversity in traffic and to resemble geometry and surroundings in the calculation model as well as possible. In figure 1 the measurement locations are shown.

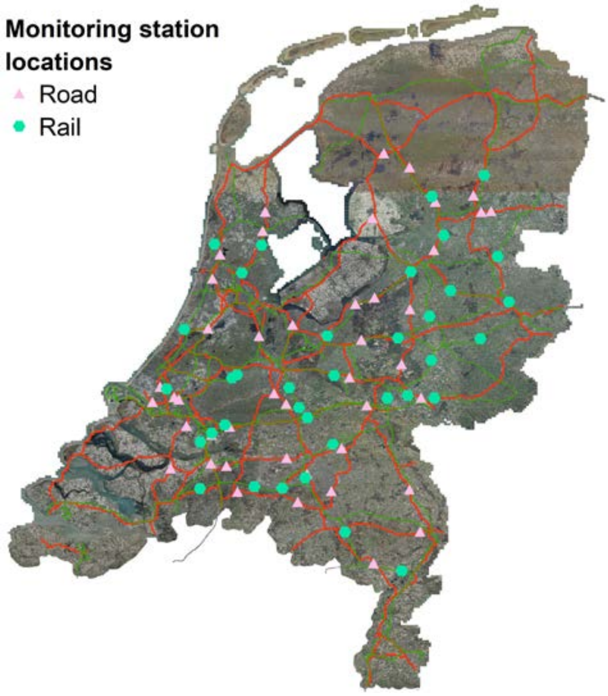

Figure 1. Location of noise monitoring stations along highways and railroads in the Netherlands.

For the choice of measurement location, the surrounding area needs to offer an acoustically open view and there should be no interfering noise sources to make a fair comparison to the calculated values. Public lampposts are used to support the measurement equipment at the required height of 4 meters.

Measurements are performed with simple Noise Sentry dataloggers. Due to this relatively low-cost solution, we operate more measurement locations for the same cost. We deemed good coverage to be more important than exact noise levels at a specific location.

We measure noise levels at each measurement location for one consecutive year spread over two calendar years. With this, we obtain data from summer to winter in one year and from winter to summer in the next year. Measurements at half of the measurement locations are done in the same period. After this period, the dataloggers are moved to the other half of the measurement locations. We repeat this measurement procedure every year. The consequence of this schedule is that each year the period measured changes from the first six to the last six months in a year and vice versa. This way, we have data during different meteorological conditions. We consider measuring half a year for each location to be representative for determining the measured annual average L_{den}.

During the measurement period, 3-minute A-weighted sound energy average (L_{Aeq}) values are continuously stored alongside motorways, and 2-minute L_{Aeq} values alongside railways. With the limited data storage for the dataloggers, this means a field visit every 15 weeks for the measurements alongside motorways and every 10 weeks for the measurements alongside railways. With each field visit, the measurement location is checked for irregularities and the sensor is calibrated by a simultaneous measurement (15 minutes) with a class one sound level meter. We have found that the dataloggers perform reliably even after months of operation. Measurements are now performed according to the upcoming national measurement regulations [2] which is based on ISO 1996-2:2017 [3].

The annual average L_{den} for each measurement location is determined in the following manner: First, railroad samples that do not contain noise from a train passing by (that only contain background noise) are given an arbitrarily low L_{Aeq} value of -99 dB (we do not remove these samples to keep postprocessing simple). This is, of course, not done for roads. In both cases, all L_{Aeq} samples in the same hour of a single day are combined to an hourly L_{Aeq} value for that day (20 samples for road en 30 samples for rail). In the next step, hours where the average windspeed is greater than 5 m/s are removed from the dataset. Measurements with precipitation are kept. For each of the 24 hours in a day, a yearly average value is calculated by averaging the valid hourly L_{Aeq} values of each day (all averaging is done energetically). We now have a yearly averaged value for every hour in a day, and calculating the L_{den} is trivial.

3. 10-YEARS OF MEASURING

3.1 Noise productions over the last 10 years

An example of a measurement location alongside a highway is shown in figure 2.

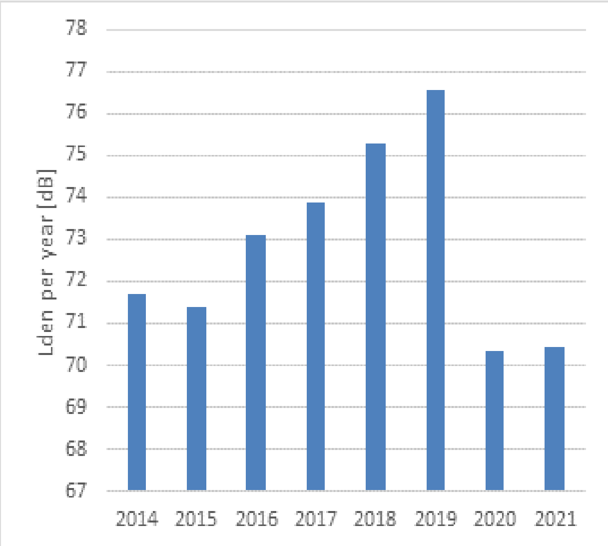

Figure 2. Measurement results of a location alongside a highway.

In figure 2 a clear pattern is seen due to road surface degradation of the low noise road surface. Somewhere between the measurements in 2019 and 2020 the road was repaved, and noise levels dropped dramatically. The advent of measures due to the outbreak of Covid and a reduction of the speed limit during daytime also led to a reduction of 1.1 dB on measured noise levels in 2020. Because the Covid measures and reduction of speed limit coincidentally started at exactly the same time we see both effects combined. This reduction in speed limit will have had a different effect for different locations. In 2020 the speed limit on highways went to 100 km/h during the daytime, before it could be 100, 120 or 130 km/h depending on location.

When we consider all measurement stations and compare calculated noise levels with measured noise levels, we get the following averaged results for road and rail.

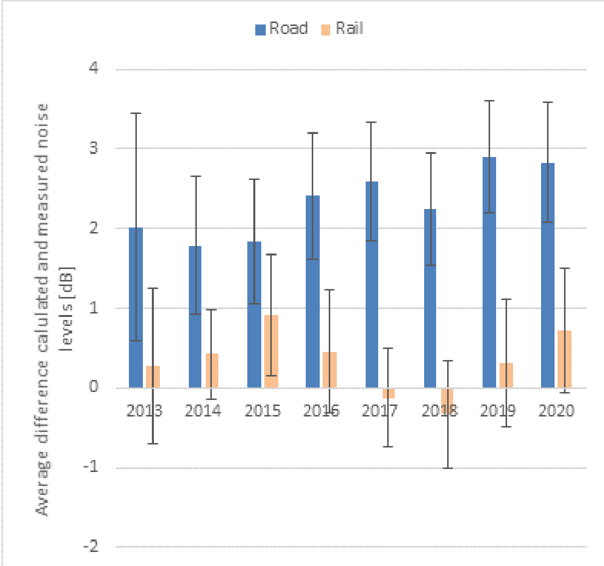

Figure 3. Average difference of measured noise levels and calculated levels. A positive value means that the measured noise level was higher than the calculated one.

In figure 3 it is shown that on average for rail traffic noise the measured noise levels correspond very well to the calculated levels. This is in contrast to road traffic noise, where there is a consistent difference of 2 to 3 dB. There is caused by two aspects in the calculation model. The first one is that tighter limits on noise produced by tyres were expected to lead to lower noise levels. In the calculations, this was already anticipated for by applying a 1 or 2 dB (depending on road surface) reduction in emission. However, as of yet, the measurements show no effect of quieter tyres. The second reason is an underestimation of emission values of vehicles at higher speeds. Because we see this consistent difference and no improvement over time, this observation has led to a redetermining of emission values and a removal of the “quiet tyre” correction from the method. When this takes in effect in 2024, we expect that measured and calculated levels will show much better agreement.

3.2 Special results

For some locations alongside railroads we can link the measured noise data to data about train type and composition registered by monitoring stations from the railway authority nearby. These monitoring stations also register speed of the trains. For each train passing by we can calculate the expected immission (depending on train type, length, speed and the track it was running on) at the measurement point and compare it to the measured noise immission. An example of a result of the average for different train types is shown in figure 4.

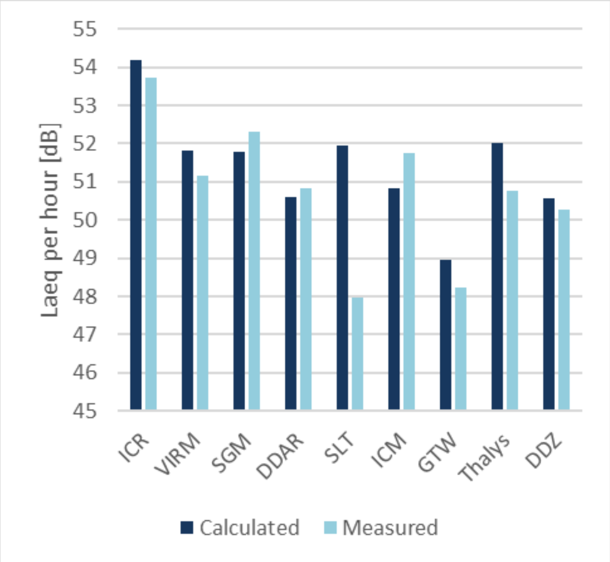

Figure 4. Comparison of calculated and measured immission values for different train types.

In figure 4 it is shown that generally the measured and calculated levels are comparable. The one exception is the SLT (Sprinter Light Train). This observation has led to further study and new emission values incorporated in our calculation method [4] for this type of train.

3.3 Lessons learned

By having this monitoring network up and running for almost a decade we have gathered a lot of valuable information. It also shows that the calculation model can work very well. It has been a tool to adjust emissions in the national calculation method. Due to the long-term measurements, we get information on:

- Changes in emission (at higher speeds)
- Road and Rail degradation
- Effectiveness of quieter tyres or quiet brakes for rail vehicles

A second strong point is that it gives us faith in our calculation method, the method of setting limits on noise production of motorways and railways. This also helps for the acceptance of the methods by the general public.

4. INNOVATIONS

After 10 years of steady operation, the dataloggers are reaching their 'end-of-life'. To continue this network, we will replace all Noise Sentry dataloggers with NSRT MK3 dataloggers from Convergence Instruments, which contain a type 1 digital MEMS microphone. This is an improvement in data quality as the Noise Sentry dataloggers are equivalent to class 2 sound level meters. Also, time resolution will be increased to between 1 and 10 seconds.

Additionally, we are working on using the OEM version of the same datalogger. We will combine this with an Arduino that is capable of remote data communication through narrow band. With remote data communication, data retrieval field visits are no longer required and proper functioning of the equipment can be monitored daily. Field visits will however still be necessary for calibration purposes, but these visits will take less time for each station allowing us to calibrate more stations in a single day. We expect to have this setup operational before the end of the year.

5. REFERENCES

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