THE QUIET PROJECT- A NATIONAL ENVIRONMENTAL NOISE SURVEY UNDERTAKEN DURING LOCKDOWN

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1 INTRODUCTION

The COVID19 lockdown created a new kind of environment both in the UK and globally. Environmental noise levels changed dramatically as communities across the UK followed Government's advice to "Stay home", and later, to "Stay safe". With the realisation that this presented a unique opportunity to measure a national noise baseline, the Quiet Project was conceived [1]. A working group was rapidly formed to engage the acoustic community in the project. This working group defined the scope of the data to be gathered and was endorsed by the Institute of Acoustics [2], Association of Noise Consultants [3], Noise Abatement Society [4] and UK Acoustics Network (UKAN) [5]. A paper detailing the setup of the project, early results on the quietest locations and two case studies which matched traffic flow to noise levels has been published [6].

2 METHODOLOGY

During lockdown employees were furloughed in the UK. This provided the opportunity to utilise their expertise and spare time to undertake measurements and observations. The immediate issue was that, as lockdown happened overnight, instrumentation was not available. This was solved by utilising UKAN to cover the shipping costs and leaning on the goodwill of leading acoustic instrumentation companies to organise the equipment, which was very kindly provided free of charge. Once the instrumentation was organised, an electronic pamphlet was produced which outlined how the measurements were to be taken: only locations on property where explicit permission had been granted were used for the study, i.e. back gardens and balconies. Next, the project needed publicity, which was ably supplied by the Institute of Acoustics through their weekly Zoom meetings. A website was designed and developed in early April 2020 to advertise the project, provide instructions to the volunteers, and to supply the templates for data formatting and observations as well as hosting the databank. It was then agreed (being a publicly funded project) to make the data available publicly whilst providing assurances with regards to data protection.

Long term measurements were to be taken using calibrated and certified Class 1 or Class 2 noise monitoring equipment [7] in accordance with BS7445 [8]. This approach would minimise uncertainty in the data set. An Excel sheet template was provided to all participants, which included approximate GPS location, façade correction, measurement height of the instrumentation, and start and end times.

It was decided by the working group that noise measurements should be made at 15 minute intervals, starting on the hour. This matched the UK TRIS (Traffic Information System) data logging interval, as road traffic is normally the primary noise source in the UK [9]. The acoustic parameters: LAeq, LAFMax, LA10, LA50 and LA90 were to be recorded with the option of including noise spectra data.

3 RESULTS

The project produced 102 datasets covering the UK and Ireland forming 1010 days' worth of high quality environmental noise measurements either taken in octaves, third octaves or averages. The overall parameters have been divided into day (07:00 to 19:00), evening (19:00 to 23:00) and night

(23:00 to 07:00) periods. These will be presented as weighted logarithmically averaged noise levels for three settings: urban, rural, and suburban (as defined by the user). The total number of 15-minute time periods monitored for each setting for each spectral characteristic is given in table 1. The type of location was verified using GPS data, user photos and Google Maps. Logarithmic averaging for day, evening and night for LAeq, LA10, LA50, LA90, LAFMax was undertaken using MATLAB; in addition, linearly calculated standard deviations will be presented.

Table 1: Summary of the number of individual time periods and (datasets).

	Averaged Data	Octave Data	1/3 Octave Data	Total
Rural	421 (1)	6799 (10)	3860 (5)	11080 (16)
Suburban	20709 (12)	31542 (40)	15622 (14)	67873 (66)
Urban	1232 (3)	9002 (8)	7743 (9)	17977 (20)

It is recognized that temporal derived averaged sound levels (L_N) should not be averaged with other temporal derived averaged sound levels. However, to gain an understanding of this unusually aural environment it was felt that additional understanding could be derived from this analysis.

3.1 Urban Environment

For the Urban environment one dataset had to be removed as it had no statistically derived average sound level (LA10/LA50/LA90) data, resulting in 19 datasets, a total of 17963 15-minute measurement periods, 187.1 days- a loss of data of 0.08%. Results for the urban environment are presented in table 2.

Table 2: Averaged Urban Noise Levels by Day, Evening and Night for Four Parameters

	LAeq (dB)	LA90 (dB)	LA10 (dB)	LAFMax (dB)
Day	60.6 σ=4.4	52.1 σ=3.8	63.3 σ=4.5	81.9 σ=7.7
Evening	57.6 σ=5.2	47.9 σ=4.4	59.9 σ=5.0	79.7 σ=8.6
Night	52.2 σ=5.9	44.3 σ=5.4	54.4 σ=6.3	71.0 σ=9.5

It has been established that if the sound source was primarily traffic, then the LA10 should be approximately 3 dB higher than the LAeq value [10]. In this case the difference was always less than 3 dB suggesting that the source of noise was not primarily traffic, see Table 2. The Day averaged noise levels were higher than the Evening, which were higher than the Night values for all parameters. The standard deviation increased over the course of day-evening-night for all parameters. The maximum values as expected having the greatest degree of variation.

3.2 Rural Environment

There were 14 datasets covering 93.7 days of data- 8996 15-minute intervals used in the averaging. Two datasets were removed due to high sound levels recorded, at least 11 dBA higher than the next highest locations' averaged sound level, making them extreme outliers. This resulted in a 18.8% reduction in the dataset. Results for the rural environment are presented in Table 3.

Table 3: Averaged Rural Noise Levels by Day, Evening and Night for Four Parameters

	LAeq (dB)	LA90 (dB)	LA10 (dB)	LAFMax (dB)
Day	51.9 σ=4.8	42.9 σ=4.5	54.0 σ=3.8	78.5 σ=6.6
Evening	47.8 σ=6.9	41.5 σ=5.6	49.2 σ=5.6	68.5 σ=8.4
Night	48.0 σ=9.3	40.6 σ=7.1	51.0 σ=7.2	68.4 σ=11.4

From Table 3 during the Night there was found to be a 3dB difference between averaged rural LA10 and LAeq values, indicating that road traffic was the primary sound source at this time of day. The Evening and Night values were similar for all parameters, indicating a lack of activity during the evenings. The variance in all acoustic parameters again increased over the course of the day-evening-night and maximum levels had the greatest standard deviation.

3.3 Suburban Environment

There were 63 datasets covering 663.9 days of data, 63733 15-minute intervals, used in the averaging. Three datasets were removed due to high sound levels recorded, at least 5 dBA higher than the next highest locations' averaged sound level. This resulted in a 6.1% reduction in the dataset. Results for the suburban environment are presented in Table 4.

Table 4: Averaged Suburban Noise Levels by Day, Evening and Night for Four Parameters

	LAeq (dB)	LA90 (dB)	LA10 (dB)	LAFMax (dB)
Day	53.4 σ=4.5	42.9 σ=3.5	55.1 σ=4.5	75.7 σ=6.9
Evening	51.1 σ=5.6	40.4 σ=4.1	53.1 σ=5.8	79.3 σ=8.3
Night	48.0 σ=7.4	38.5 σ=5.9	50.8 σ=7.8	76.0 σ=10.1

From table 4, the Day averaged noise levels were higher than the Evening, which was higher than the Night values for all parameters. The standard deviation increased over the course of day-evening-night, again for all parameters. The maximum values again had the greatest degree of variance.

This demonstrates the consistency in all the measured parameters during all time periods for all three environments. Thus, these results show the value in the early decision to use only high-quality instrumentation to take the measurements as used by experienced acousticians. This approach could be called scientific crowd sourcing of measurement data.

3.4 Comparison of 24-Hour Averages

By reanalysing the dataset used to create Tables 2, 3 and 4 the overall average sound level for the three environments could be calculated. Allowance was made for the duration of the measurement to create a weighted logarithmically averaged value for the four acoustic parameters under consideration, see Table 5.

Table 5: Rural, Suburban and Urban Noise Levels over 24-Hour periods for Four Parameters

	LAeq (dB)	LA90 (dB)	LA10 (dB)	LAFMax (dB)
Rural	50.3 σ=8.5	42.0 σ=6.5	52.5 σ=8.8	75.9 σ=10.8
Suburban	51.9 σ=7.2	41.0 σ=5.3	53.8 σ=7.5	76.7 σ=10.1
Urban	58.6 σ=7.4	50.0 σ=6.9	61.2 σ=7.8	79.9 σ=9.5

Table 5 shows great consistency in terms of standard deviation over both the measurement environment and acoustic parameters. This provides confidence in the dataset. The data also showed that the Rural and Suburban acoustic environments were very similar, with all parameters showing an average difference of 1.6 dB for LAeq, 1.0 dB for LA90, 1.3 dB for LA10 and 0.8 dB for LAFMax. The Urban environment was significantly noisier 6.7 dB for LAeq, 9.0 dB for LA90, 7.4 dB for LA10 and 3.2 dB for LAFMax than the Suburban environment. This goes against current DEFRA definitions with only rural and urban environments currently recognized [11].

3.5 Overall National Average

To provide a national average for UK and Ireland the measurements, 90692 15-minute intervals or 944.7 days, noise levels for three environments over three time periods were weighted and logarithmically averaged for the four acoustic parameters under consideration, see table 6. This calculation involved the rejection of 6.4% of the original dataset, see sections 3.1, 3.2 and 3.3.

Table 6: Nationally Averaged Noise Levels by Day, Evening and Night for Four Parameters

	LAeq (dB)	LA90 (dB)	LA10 (dB)	LAFMax (dB)
Day	56.0 σ=4.5	46.6 σ=3.7	58.8 σ=4.6	78.0 σ=6.9
Evening	53.2 σ=5.8	43.3 σ=4.4	55.4 σ=6.0	78.9 σ=8.4
Night	49.2 σ=7.6	40.6 σ=6.0	51.8 σ=8.0	74.8 σ=10.1
Daily	54.2 σ=7.6	44.9 σ=4.9	56.5 σ=7.0	77.5 σ=9.7

From table 6, as expected, the Day averaged noise levels were higher than the Evening, which was higher than the Night values for the three main acoustic parameters. The standard deviation increased over the course of day-evening-night, again for all parameters. The maximum values had the greatest degree of variance. This demonstrated consistency amongst the measured parameters and their respective time periods. There was a 2.8 dB difference between LAeq and LA10 for the daytime measurements, indicating that traffic was the primary sound source. This was reduced to a 2.2 dB and 2.6 dB difference in the evening and night-time periods, respectively.

4 COMPARISON WITH NATIONAL SURVEYS

A comparison with the England and Wales National Noise Incidence Survey (NNIS) data [12,13] was undertaken. The latest NNIS 2000/2001 was of a similar size, 1160 days measured at the façade facing the road over 24-hour periods taken throughout the year. The NNIS are similar in size to the Quiet Project, although all the latter's measurements were taken during the Spring of 2020. Note a 3 dB allowance was made for the Quiet Project data to account for the façade correction. It should also be noted that the NNIS took a representative sample of English and Welsh residences whereas the Quiet Project were typically taken in the back garden of acousticians' homes across England, Scotland and Ireland [6]. Table 7 shows the percentage of locations (time interval weighted) in 5 dB categories based on measured LAeq, 16 hour noise levels.

Table 7: Percentage of locations based on measured Day/Evening noise levels in 1990, 2000, 2020 surveys.

	1990	2000	2020
LAeq, 16 hours <50 dB	8%	10%	8%
50< LAeq, 16 hours <55 dB	32%	35%	41%
55< LAeq, 16 hours <60 dB	30%	30%	32%
60< LAeq, 16 hours <65 dB	18%	15%	16%
LAeq, 16 hours >65 dB	12%	10%	4%

It can be seen from Table 7 that the percentages of locations with Day-Evening noise levels period below 50 dBA has remained steady at 8%. However, the percentage of locations with a 50-55 dBA noise level has steadily increased to 41% over a 30-year period. The 55-60 dBA noise level has remained steady at 32%. The 60-65 dBA noise level was also steady at 16%, whilst the above 65 dBA has dropped to 4% during the lockdown. This strongly indicates that the Quiet Project did indeed measure the UK and Ireland baseline environmental noise condition.

Turning to the Night-time noise levels a comparison was again undertaken with the NNIS 1990 and 2000/2001 data, see Table 8.

Table 8. Percentage of locations based on measured Night-time noise levels in 1990, 2000, 2020 surveys

	1990	2000	2020
LAeq, 8 hours <45 dB	34%	32%	10%
45< LAeq, 8 hours <50 dB	32%	36%	32%
50< LAeq, 8 hours <55 dB	19%	18%	42%
LAeq, 8 hours >55 dB	15%	16%	16%

From Table 8 a distinct difference in Night-time noise levels can be seen between the 1990 and 2000 datasets compared to Quiet Project. The below 45 dBA noise level was only 10% compared to approximately 33% in 1990 and 2000/2001. The 45-50 dBA was steady at 32%. However, the 50-55 dBA significantly increased to 42% from 18%. The above 55 dBA category was steady at 16%. This indicates that the Night-time noise environment had significantly increased.

In the NNIS 2000/2001, the most recent national noise measurement data, the $L_{Aeq,\ Day}$ was 57 dB, and the $L_{Aeq,\ Night}$ was 48 dB whereas the façade corrected Quiet Project dataset found an average $L_{Aeq,\ Day}$ of 58 dB and $L_{Aeq,\ Night}$ of 52 dB. So, a small day time increase of 1 dBA, but a more significant 4 dBA increase during the night over a 20-year period has been found.

5 CONCLUSIONS

The Quiet Project demonstrated that it was possible for a community to be brought together to undertake a large-scale noise survey under a tight deadline. This was thanks to preexisting plans put in place after transatlantic flights were stopped for one week during the Icelandic volcano eruption of 2010. The Quiet Project produced a representative sample of outdoor environments measured across the home countries at one hundred locations over an average of 10 days at 15-minute time interval resolution creating more than 1000 days of data.

The results showed that different types of environments have different noise climates which changed each significantly over the course of a day. This may need to be recognised in future guidance and regulation.

When the dataset was compared to existing National Noise Surveys a trend in increasing noise levels was found averaging out as a 1 dBA increase during the day-evening and a more significant 4 dBA increase during the night-time.

The Quiet Project dataset will be made freely available to analyse in Excel format [1]. A suggestion for further analysis would be the frequency of LAFMax exceedances, which has been found to be very difficult to predict [14]. The percentage of locations which meet current WHO guidance [15-17] and recommended L_{DEN} noise levels may also be of interest. Finally, the next stage of the project is to undertake a cross analysis of the Soundscape dataset with each locations' noise measurements.

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REFERENCES

1. www.thequietproject.co.uk [bring updated as of 2 April 2024]
2. www.ioa.org.uk [accessed 2 April 2024]
3. www.association-of-noise-consultants.co.uk [accessed 2 April 2024]
4. www.noiseabatementsociety.org [accessed 2 April 2024]
5. www.acoustics.ac.uk [accessed 2 April 2024]
6. S. Dance, L. McIntyre. The Quiet Project- UK Acoustic Community's response to COVID19, Noise Mapping, 8, 32-40, 2021, https://doi.org/10.1515/noise-2021-0003
7. IEC 61672-1:2013 Electroacoustics: Sound level meters- Part 1 Specification, Geneva, Switzerland.

8. BS7445 -1:2003 Description and measurement of environmental noise, BSI Group, London
9. www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic [accessed 2 April 2024]
10. G. Abbott, P. Nelson. Converting the UK traffic noise index LA10,18h to EU noise indices for noise mapping, Project Report PR/SE/451/02, Transport Research Laboratory 2002
11. DEFRA Statistical digest of Rural England 2020 https://assets.publishing.service.gov.uk/media/617932b6d3bf7f5604d83d7a/Rural_population__Oct_2021.pdf [accessed 22 June 2024]
12. C. Skinner, C. Grimwood. The National Noise Incidence Study 2000/2001 (United Kingdom): Volume 1 – Noise Levels. Building Research Establishment, BRE report 206344f, 2002.
13. A. Moorhouse. Environmental Noise and Health in the UK, Health Protection Agency 2010.
14. A Brown. Supplementary road traffic noise metrics for practical management of awakenings by road traffic noise events, Proceedings of 14th ICBEN Conference, Belgrade, Serbia 2023
15. Guidelines to Community Noise, World Health Organisation 1999, Geneva, Switzerland
16. Night Noise Guidance for Europe, World Health Organisation 2009, Genea, Switzerland
17. Environmental Noise Guidelines for the European Region, World Health Organisation 2018, Geneva, Switzerland.

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