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The Case for Spectral Measurements of Ambient Noise Levels in the Assessment of Wind Farms

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Abstract

Low frequency noise emissions from wind turbines have in recent years been highlighted as an issue of concern by residents in proximity to wind farm developments.

Noise measurements taken after the commissioning of the wind farms generally only include spectral information to determine the frequency content after noise complaints have been received and a compliance type of investigation is being carried out.

Noise measurements undertaken before the approval of a wind farm development typically consist of overall levels only, using broad-band noise loggers without spectral capability. The relationship of the spectral sound energy before and after commissioning of the wind farm development is not well quantified.

Several one-third octave noise loggers were used in combination with meteorological measurements at two different reference heights, to evaluate the low frequency content of baseline noise records as well as the contribution from seasonal and episodic biological noise. The effects of the wind speed profile on the measured ambient noise levels were also examined. Examples are presented that contrast the conclusions that can be drawn from spectral noise monitoring compared with broad-band noise logging.

Introduction

The purpose of ambient noise measurements taken during the planning phase of a wind farm development is to identify the existing noise levels in the area surrounding the proposed wind farm. These measurements are often described as the baseline noise assessment, which are fundamental to the assessment and determination of noise emissions limits for large infrastructure or industry developments, including wind farms.

Noise complaints after the commissioning of a wind farm often include reference to the character of the noise or low-frequency content of the noise from the wind farm. To truly assess the effects of the wind farm requires the knowledge of what the noise environment was like before the installation of the development. An additional reason for having a better understanding of the spectral information before the installation of

a wind farm is to ensure an accurate determination of the background noise levels and thus the resultant noise criteria.

Downsides to Broadband Noise Logging

Statistical information is not sufficient to determine extraneous noise. Guesses can and are often made as to what particularly noises ‘could’ be but such decisions are made based more on past experience of the consultant and guesswork than specific information available through the data recorded by the logger.

Examples of extraneous noise are dependent upon the type of noise being measured, very often including insect noise and fauna such as bird calls or frog noise. This type of noise can be seasonal and is not present for a significant part of the year. If this type of noise is measured, enough information is not present in broadband noise logging to allow for any adjustments to be made, with the data often having to be discarded. This would not be a problem in the ideal world, as the consultant could just wait until the part of the year where this noise is not present so the most accurate measurement could be taken, or alternatively conduct measurements for the entire year. The pressures of the real world however bring limited budgets as well as limited timeframes for measurements to be conducted ie. “start straight away and finish as soon as possible”.

Advantages of Spectral Noise Logging

Advances in instrumentation has made the spectral measurements more easily available, ranging from the simple octave measurement to one third octave measurements to digital audio recordings, allowing replaying or FFT analysis to identify noise sources after the measurements are conducted.

With the additional spectral information available, determination of the noise source in question is aided significantly. Insect noise is particularly simpler to identify and remove, as constant noise of significant level in the 2.5kHz to 5kHz bands are not usually present in the majority of environmental noise measurements. This information allows the use of mathematical algorithms to extract or remove the contributions of specific frequency bands and recalculation of the aggregate overall noise levels forming the baseline noise.

Case Study: Ambient Noise Study with Wind Data

The 24 hour time history presented at the top of Figure 1 represents the ambient noise environment in a regional environment in regional Queensland, as would typically be presented from the results of a Type 1 broad-band noise logger with the associated meteorological information. The bottom part of this figure shows the additional information provided by the one third octave logger, presented as a sonogram.

The noise survey was conducted in February 2011, with no possibility of monitoring during winter months. In this instance the project budget did not allow for more than a week of noise logging.

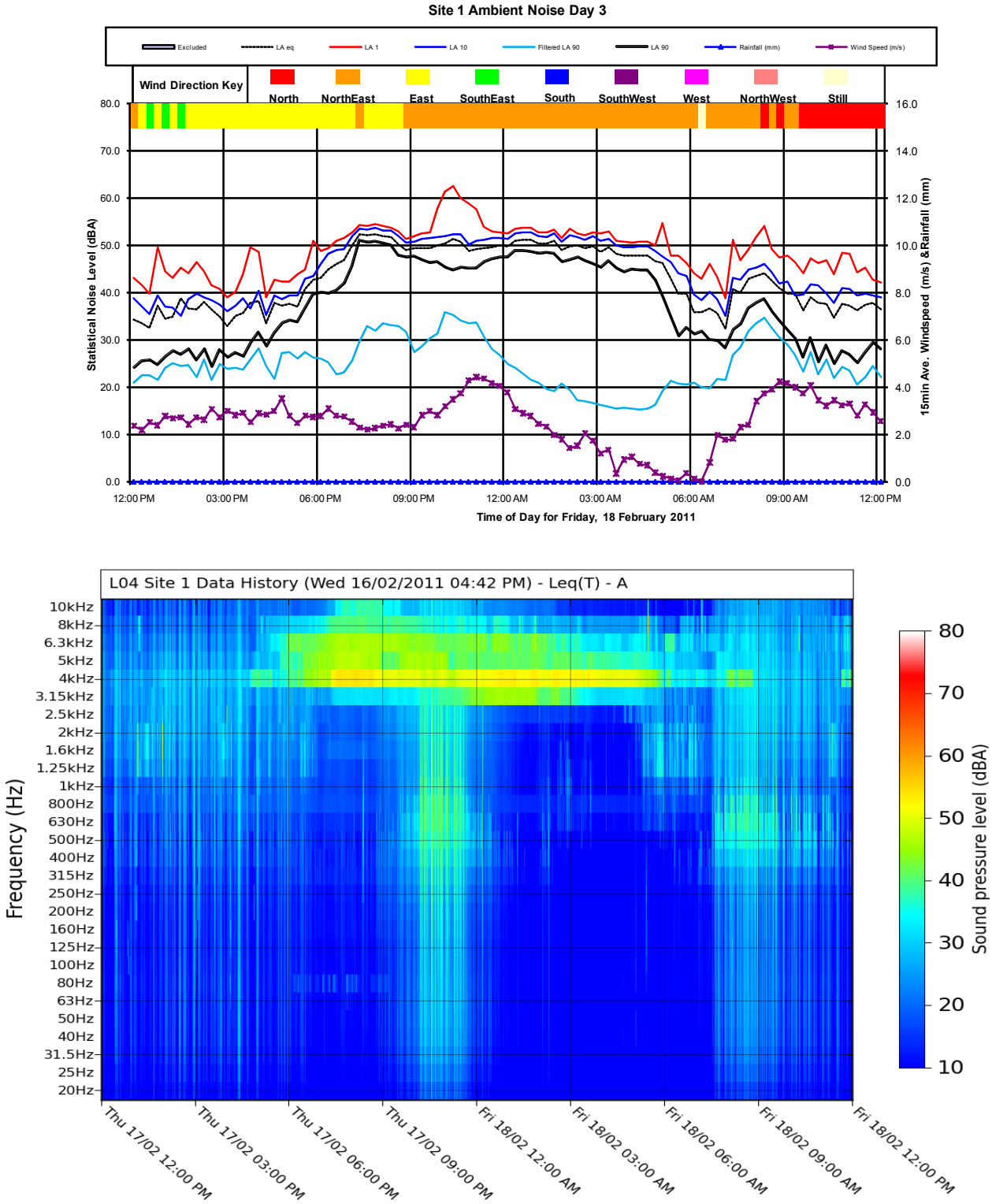

Figure 1: Statistical Baseline Noise Record and One-third Octave Sonogram – Site 1

From the broadband record it can be seen that the noise levels during the night period are above the day period and have a reasonably small spread which is difficult to qualify. There is however not enough information to identify the types of noise present and whether it is representative of the noise environment for the entire year. This would, if handled without due consideration, result in determined background noise levels and resultant noise criteria which are significantly inflated and would possibly result in noise complaints in the future.

From the one-third octave spectral record shown in the lower portion of Figure 1, insect noise is evidenced by 3.15kHz to 8kHz banding during the evening and night period. When the one-third octave record is used to remove the insect noise within the 3.15kHz to 8kHz bands, a substantial reduction in the Assessment Background Noise Level (ABL) results as illustrated in Table 1. Without this adjustment and overestimation of around 17dB would have resulted for the Assessment Background Noise Level.

Table 1: Assessment Background Noise Level with and without insect noise

	Raw Data	Filtered Data (Filters Exclude: 3.15 kHz 4 kHz 5kHz 6.15kHz 8 kHz)
Day, 7am to 6pm	24	21
Evening, 6pm to 10pm	40	22
Night, 10pm to 7am	33	16

The data is presented in a way more familiar to those who carry out wind farm assessments in Figure 2, which includes the data as a LA90 noise level against wind speed for both the raw data and that with the insect noise filtered out. For each set of data a 2nd order polynomial trend line is shown.

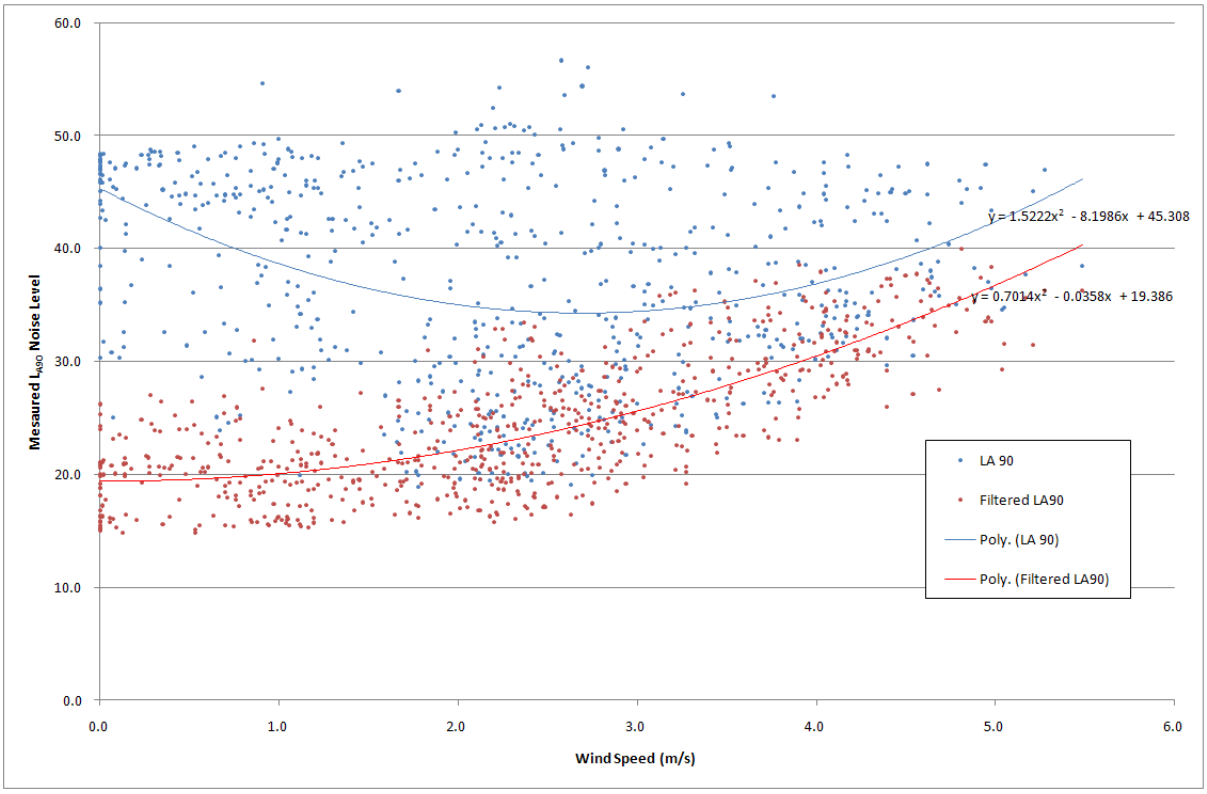

Figure 2: Site 1 Measured Noise Level Vs Wind Speed (m/s)

From the data shown in Figure 2, it can be seen that the insect noise shown in the original data set significantly obscures the relationship which is intended to be studied, as the insect noise is not significantly dependant on the wind speed. When the one-third octave record is used to remove the insect noise within the 3.15kHz to 8kHz bands, a more understandable and reasonable trend line emerges, which is significantly different to that produced by the raw data. If the raw data was used, the noise criteria resulting from the assessment would be significantly inflated and would be unlikely to be remotely reasonable for periods of the year where little or no insect noise is evident.

Conclusions

Assessments of background noise levels utilising broadband noise loggers can result in an overprediction of the ambient noise levels of up to 17dBA with a similar inflation of the determined noise criteria due to the inclusion of seasonal biological noise such as insects.

Spectral noise logging allows for the identification and removal of extraneous contributions with a greater degree of confidence, using mathematical algorithms to extract or remove the contributions of specific frequency bands and recalculation of the aggregate overall noise levels forming the baseline noise (such as ABL or RBL). Using this method the relationship between wind speed and ambient noise level can be confirmed without the influence of seasonal biological noise, which would

otherwise significantly distort the assessed relationship between wind speed and ambient noise level.

The use of spectral noise measurements is also anticipated to help with noise complaints as the before and after spectral content will be known, allowing for a more rigorous assessment of both low frequency noise and any identified tonality.