Associazione Italiana di Acustica
44° Convegno Nazionale
Pavia, 7-9 giugno 2017

ANOMALOUS NOISE EVENTS CONSIDERATIONS FOR THE COMPUTATION OF ROAD TRAFFIC NOISE LEVELS IN SUBURBAN AREAS: THE DYNAMAP'S ROME CASE STUDY

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ABSTRACT

Encouraged by the European Directive 2002/49/EC on environmental noise, the DYNAMAP project is aimed at implementing a dynamic noise-mapping system able to determine the acoustic impact of road infrastructures in real time. To that end, the noise maps are updated using the information retrieved from a low-cost monitoring network. However, for a proper evaluation of the road noise level, acoustic events unrelated to traffic should be removed before updating the noise maps. In this work, an analysis of the distribution of such events in different locations of the Rome case study and their impact on the overall noise level is described.

1. Introduction

The alarming rise of environmental noise pollution led the European Union to encourage updating the noise maps of certain city areas in a maximum period of five years [1]. To that end, the DYNAMAP project (LIFE13 ENV/IT/001254) is deploying a low-cost Wireless Acoustic-Sensor Network (WASN) in order to monitor the traffic noise sources in real time [2, 3]. Rome and Milan are the two pilot areas where the system is tested, as an example of suburban and urban areas respectively. The system will measure the sound pressure levels of traffic-related sources and update the noise maps using a Geographic Information System (GIS) [4].

However, in order to reflect the Road Traffic Noise (RTN) correctly, the acoustic events unrelated to road traffic, namely Anomalous Noise Events (ANE), should be removed from the noise map computation [5–7]. The goal of this paper is to study the impact of excluding these anomalous events in several measurement spots and to see if any distinction should be applied between the recording locations within the Rome pilot area. The chosen metric for the noise calculation is the equivalent noise level after an A-weighting is applied, i.e. LAeq.

The paper is structured as follows. Section 2 describes the Rome suburban scenario and the analysis of the ANEs is detailed in Section 3. The conclusions are presented in Section 4.

2. The pilot area of Rome

The pilot area of Rome is located along the Motorway A90 that encircles the city. The motorway is a six lanes road, 68 km long, skirting many suburban areas where noise levels were found to impact critically on the residents. Critical areas are characterized by the presence of single or multiple noise sources, such as railways, crossing roads and parallel roads [8]. Consequently, the overall noise level at receivers depends on the number and contribution of the noise sources present in the area. Since the Environmental Noise Directive 2002/49/EC [1] states that the noise impact of each main source should be determined and reported separately, the influence of the other noise sources should be eliminated or at least dramatically reduced. To meet such a requirement, noise levels should be measured on suitable sites to contain the influence of the exogenous sources as much as possible, or the monitoring devices should be provided of a smart algorithm able to detect and eliminate the contribution of the sources unrelated to RTN, denoted as Anomalous Noise Events Detector (ANED) [5–7]. Thus, in order to check the feasibility of revealing and deleting such anomalous noise events, including temporary spurious events, with the ANED algorithm, test sites with different acoustic characteristics, representative of the main suburban scenarios, were selected, as follows [8]:

A. sites embracing only the primary road (A90 Motorway);
B. sites with additional crossing or parallel roads;
C. sites with railway lines running parallel or crossing the A90 motorway;
D. complex scenarios including multiple connections.

In the end, the pilot area of Rome has been composed of many test sites, with different territorial and environmental features, distributed along the motorway A90, where 19 elementary noise sources, with invariant traffic conditions, were identified to host the DYNAMAP sensors, as shown in Fig. 1.

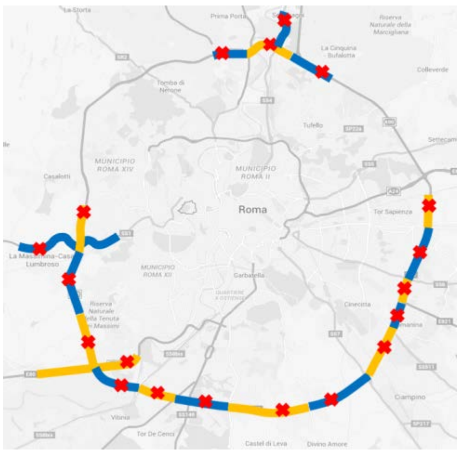

Figure 1 – Map of the sites where the DYNAMAP sensors will be installed.

3. Analysis of the ANEs

After a real life recording campaign, we were able to detect 19 classes of ANEs in both Rome and Milan scenarios [9], but only 9 of these 19 appeared in the recordings of Rome.

Associazione Italiana di Acustica, 2017
ISBN: 978-88-88942-54-4

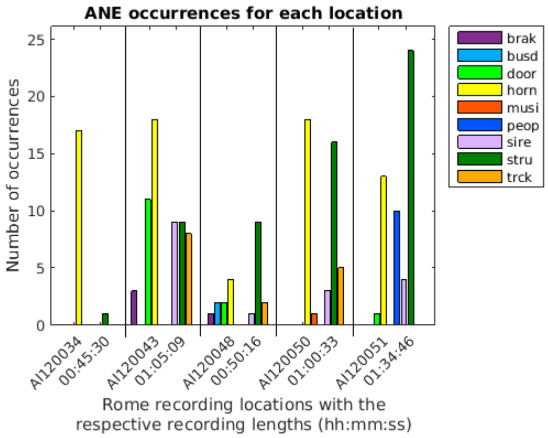

Figure 2 – Number of recorded ANEs per class and location in Rome.

Fig. 2 shows the number of occurrences for each ANE classified for each recording point of the A90 motorway in Rome. Notice that the recording time of each location affects the number of occurrences. Even so, similar kind of ANEs appear within the locations, being either the horns or the structure's sounds the most reiterated events in all of them. The behavior of the other ANEs is similar for all recording spots, being the sirens and truck-related sounds the most common events in each location. In addition, music, bus doors, doors, brakes and people talking appear in the different locations, but less often than the aforementioned ones.

The impact of removing the ANEs is shown in Figure 3 and 4 for illustrative purposes. In both cases, LAeq is plotted with and without ANEs to measure the effects of the anomalous noise events on the overall noise level computation in a 5 minutes period [2].

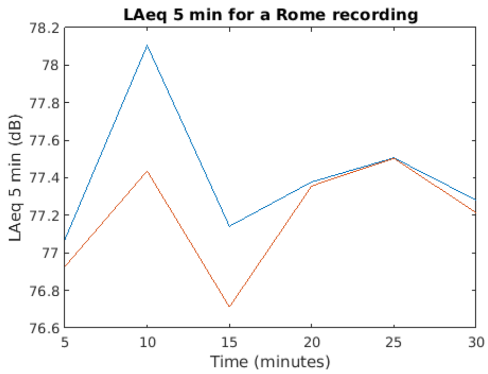

Figure 3 – Comparison of the LAeq with and without ANEs for the second part of the AI120051 scenario.

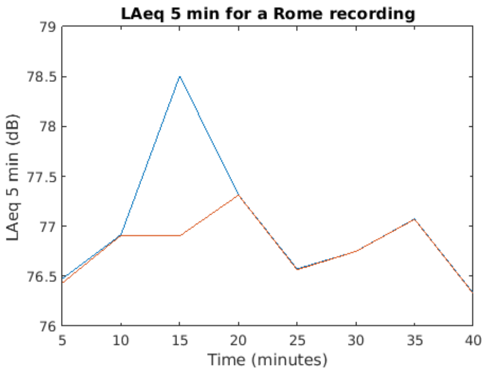

Figure 4 – Comparison of the LAeq with and without ANEs for the AI120034 scenario.

Fig. 3 shows a maximum impact of +0.7 dB while in Fig. 4, the maximum difference between LAeq values with and without ANEs is 1.6 dB. Hence, in both cases, removing the anomalous events from the LAeq measurement implies a sound level decrease.

4. Conclusions

From the selected examples of the Rome case study, we have observed that excluding the ANEs from the noise assessment has proven to have a positive impact, as the measured RTN level increases artificially if the ANEs are not set apart from the LAeq calculation. We can conclude that the ANED is useful and, in some cases, necessary to attain the DYNAMAP's goal, since the difference between LAeq values with and without anomalous noise events is near 2 dB for an integration time of 5 minutes. All examples record a positive impact when removing the ANEs, however, more data must be collected in order to know the real impact of the ANE detection and removal.

Concerning the noise typology, despite the locations show different behaviors in terms of ANE, there is not enough evidence to divide the recording spots in different clusters, since none of the sensor has captured a unique distinctive ANE pattern. Therefore, only one ANED will be trained in the Rome area.

5. References

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