Out of the labyrinth: lights and shadows of noise mapping in CNOSSOS era

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Summary

Noise maps according to CNOSSOS-EU common noise assessment methods are becoming a reality with the recent update of annex II of the Environmental Directive 2002/49/EC. Difficulties and differences among member states emerged from the previous round of noise maps. Thus, a long process resulted necessary to the EU to publish a new method aligning member states in the noise mapping procedure, which will be mandatory in the next round of mapping, to be held in 2022. The method will contribute to determine the exposure and communication information in a sound framework, solving the incomparability experienced with the interim approach. Besides CNOSSOS constitutes a relevant step forward to noise mapping implementation and usefulness, the effective mapping process still presents some flaws, especially in the information and action planning phases. The collaboration of experts first testing the method in real scenario also unveiled some dark sides of CNOSSOS that are still to be enlightened and fixed. The several issues arose on this topic will be summarized. The operational difficulties observed will be presented together with solution experienced in involving the population in the subject. Keeping in mind that the ultimate aim of noise policy is citizens' health care, attention will be given to the initiative that will reduce the well-known effects of noise, which has been deeply investigated in the very last decade. In this concern, noise maps have been well used for epidemiological purpose in some studies that will be presented in order to show the approaches and the indicators currently used to prevent noise health effects. In fact, proper noise mitigations cannot be realized without considering the real health risks, but instead, they should be based on health indicators targets as suggested by the directive, without simply referring to zoning limits, which unfortunately does not always keep into account people disturbance to noise.

The European Noise Directive 2002/49/EC (END) introduced the strategic noise maps and action plans as instruments for urban planning and noise management in order "to define a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to exposure to environmental noise". Maps and action plans are actually due in five years' intervals for major infrastructures (roads, railways, airports and industrial source) and agglomerations over 100,000 inhabitants.

A strategic noise map is an acoustical view of the territory, used to compare it with noise limits in order to highlight the areas where actions are needed. Action plans use the noise maps as input data to manage noise issues aiming to noise reduction where necessary and preserving quiet areas. Both noise map and action plans, however, are above all a tool to inform the citizens about the number of people exposed to the different noise levels, with the aim to involve the general public and promoting the knowledge of health risks related to noise.

The European Community produced several guidance to help Member States implementing the END so far: the Good Practice Guide (GPG) was delivered to determine maps uncertainty and guide planners efforts in gathering more accurate input. In fact, it was shown that the GPG is an accurate tool to determine accuracy depending on modeling choices especially on traffic flow issues [1]. A European END review after more than a decade since its publication reported that the presentation of consistent and comparable data on the number of people exposed to excessive noise levels in European countries appeared to be a difficult task for: 1) the incompleteness of the strategic noise mapping in Europe; 2) the different quality and format of data reported at EU level; 3) the different evaluation methods used; 4) the different strategies adopted in the selection of roads to be mapped and in the distribution of the population inside the buildings; 5) the non-availability of dose-response curves to be used for an adequate estimate of health effects. END has therefore not achieved the goal of providing a homogeneous representation of the noise problem in Europe.

The emerged problems were delays in implementation by the Member States, failure to identify national noise limits, lack of noise maps in the conurbations provided for by the law, poor communication and involvement of the public in the process of noise assessment and mitigation. These inconsistent approaches led to an unreliable comparison between Member States (MS) on population exposure to noise in EU [2].

In strategic noise mapping, despite the mandatory use of the new indicators (Lden and Lnight) specifically introduced for the comparability of exposure levels, MS continued using also other national indicators, especially for the drawing up of action plans. Marked differences in the determination of limits and their applicability emerged as well as the received data resulted not comparable between MS because, in addition to different indicators, also national methods for noise evaluation were used, with obvious non-homogeneous results. European Commission set a Working Group (WG Noise) of Experts and rapresentatives of Member States to support the process of END reviewing. Finally, the recently introduced by the European Directive 2015/996 [3] new model CNOSSOS-EU [4] for the simulation of noise propagation will solve these problems and will replace the so-called interim methods specified in the original END.

Two harmonized methods are used together with two groups of noise sources: aircraft and ‘terrestrial sources’. CNOSSOS-EU is valid for determining noise in the frequency range from 125 Hz to 4 kHz for road traffic and railway noise, from 63 Hz to 4 kHz for industrial noise and from 50 Hz to 10 kHz for aircraft noise. The general approach of CNOSSOS-EU is to break down the physical noise sources into equivalent point sources, to identify the relevant propagation paths between one equivalent source and a receiver, and to perform a point-to-point calculation for each identified path. The method for identifying paths is not specified in CNOSSOS-EU, it will rely either on ray tracing or on image source methods but is left to software developers, thus creating issues to date. Consistency and comparability of the data delivered to the EU by member states in the END framework is ensured using a common prediction method with an accuracy control of the vast amount of input data required. The uncertainty associated with individual source input parameters is fixed within 2 dB in terms of emission level.

Unfortunately many issues remains to be solved, especially in the derivation of some initial data such as the probability of occurrence of favourable conditions from meteorological data and determination of the alpha and beta coefficients for road pavements. The most obvious inconsistencies, such as the conflicting frequency bands of interest, as well as the railway model needing a lot of work and validation with the national input data, should be addressed by the commission. Finally the new model seems to differ from previous ones especially in diffracting conditions, often occuring behind the most common mitigation solutions, so measurements should be performed for verification and providing eventual corrections in a correct guidance to planners. CNOSSOS seem to be inconsistent with measurements in first tests, especially ones performed before the implementation in software.

Thus, a specific WG has been established by the EU Commission in order to fix these issues. Moreover, in the same time ISO WG 56 is working to write a new norm on giving strict indications to software developers, promoting standardization for implementing CNOSSOS.

Despite modeling issues still to be fixed, scientists have been developing studies and applications deriving from END implementations. In particular, a series of national and international projects aimed at the evaluation of health effects at large scale by taking advantages of noise maps. These studies demonstrated accuracy demand for correctly estimating the burden of disease due to noise, so further efforts are needed to improve approaches besides CNOSSOS methodology. In fact, accuracy for large scale studies still dependent on maps input data [5]. The BEEP (Big Data in Environmental and Occupational Epidemiology) project funded by INAIL Discretionary Research Plan 2016-2018 is cutting edges of mapping input data trying to use big data for traffic flow acquisition in order to estimate epidemiological data on noise. Big data coming from social applications, like Google traffic, are not the only social potentiality for END implementation. Using social media like Facebook or Twitter to communicate noise and raise awareness is a new challenge that cannot be missed. Several experiences on mapping noise through smartphones and media coming from shared platforms have been implemented also in other projects (Citizenscape, Noisetube, ...). Smart and cheap noise sensors also led to the innovation of dynamic mapping, studied since 2008 within the PLGrid Plus Project in Gdansk [6] , and are actually under implementation in the LIFE DYNAMAP project. Dynamic mapping does not only apply to road traffic, as required by the END, but also to source not yet included in the END such as the anthropogenic noise. Several studies actually ongoing aim to the detection of such noise through low cost sensors network, achieving a double benefit: from one side anthropogenic noise can be identified and removed from time history to estimate correct traffic noise maps, from the other side administrations can be informed of movida effects on populations, prevent complaints and managing noise criticalities in urban areas [7].

However, noise awareness cannot be limited to smart visualization of standard or dynamic noise maps but it should foster the citizen involvement in planning process. This can be achieved only if citizens are really able to understand the information provided. In order to do so, a number of initiatives were also focused on determining easy usable indicators to plan and to show noise exposure. A relevant and recent example is the HARMONICA project in which not only average energetic indicators required by END but also peak noise is shown to highlight disturbance of single events. Other examples of smart indicators are the ones used for action plans to define priorities, that should in fact be understood by policy makers and highlight priorities and not simply report exposure [8].

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