STUDYING THE SUITABILITY AND ADAPTABILITY OF NOISE MAPS AS A TOOL FOR HEALTH PREVENTION IN THE PROVINCE OF QUEBEC

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1 Introduction

This paper is a follow-up on the first project presented to the Canadian acoustical community in 2019 [1] about new initiatives launched by the provincial government after the publication of the Advisory on a Québec Policy to Fight Environmental Noise [2]. It aims to present a summary of the results obtained from the data classification throughout the literature review. As reported previously, the scoping review started with more than 11000 bibliographic records from which 170 scientific papers were selected.

Environmental noise mapping involves different techniques, and standards. As public authorities want to get a better understanding of what can be achieved in modern noise maps, the review looks at publications from the last 15 years to compare scientific development with general practice of noise engineering or environmental assessment. One of the main goals of the project is to share that knowledge with people that can take advantage of convenient and accurate noise maps, such as urban planners, cities, or different authorities from the provincial government.

2 Noise mapping scientific review

2.1 Selection of the bibliography

At the request of the funding partner, the project started with a scoping review on the subject of recent noise maps. The research protocol had to be adjusted according to the literature that would best covert agreed priorities of the study.

To be selected in the second level of examination, each reference had to fulfill inclusion criteria such as : the language used between English or French, the type of text, publication date really after 2003, detailed information regarding the presented noise mapping, the scale of maps (excluding small-scale analysis), good acoustics considerations, a few exclusion of particular noise sources or environment (like underwater propagation), and the availability of the paper in electronic or printed version. With two independent jurors doing this assessment on each publication, the inventory was reduced from a set of 705 abstracts obtained by keywords search in international database to a set of 170 full-length papers that would then pass to the data extraction.

2.2 Locations of reviewed studies

One of the first remarks coming from the review is that recent scientific publications on noise mapping are not common in North America, as there were only 9 papers from that part of the world. In comparison, 59 references were from Asia, and 63 from countries located in Europe. This fact raises a few questions about why noise mapping is not considered as an actual research topic in the United States or in Canada. Statistics per countries show more publications in Brazil, Turkey, China, Italy or in India alone.

Regarding the scale of interest, most examples related to citywide projects, then it is about boroughs, and areas of a few blocks like university campuses.

2.3 Preliminary findings

The scientific research on noise mapping seems to be made according to 3 different goals, which are the visual translation of noise levels in the environment for general interpretation, the design and validation of noise maps, or the calibration of noise simulations. In 16% of selected papers, two or more of those objectives were discussed.

Although 44% of the scope did not clearly list the instrumentation used for sound surveys or other related observations, there is a relatively broad inventory of methods and equipment, which includes the majority of conceivable options. About 32% percent of the papers relied on at least a precision sound level meter (class 1), while 8% used more economical technology like smartphone apps and devices. In the category summarizing other types of instrumentation, there were several cases of audio-video recordings allowing post-processing or documentation of sound events, as well as geolocation tools. In addition, at least 21 references opted for more than one class of measurement instruments.

Through the reading of chosen scientific papers, it was not always easy to determine exactly how many surveys were included in each analysis. The graph in Figure 1 provides a relative summary of the number of field measurement locations listed by authors, considering 4 categories.

In some cases, the number of measurement points may be confused with the sampling scale used to produce the noise maps, like the resolution grid in simulations. Nearly half of articles reported assessments of 100 measurements or less, while only a few references appeared to have sampling of more than 1000 measurements.

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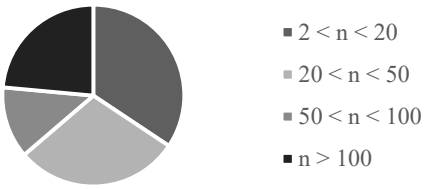

Figure 1: Number of measurement locations (n) used for noise maps reported in selected papers from the scoping review

The data extraction from those 170 publications allowed the comparison based on many parameters like:

a) Height of noise level measurements above ground,
b) Measurement interval,
c) Time of the day taken into account,
d) Noise standards or policy used,
e) Noise level indicators (L_{eq}, L_{den}, $L_{n\%}$, etc.),
f) Type of noise surveys (short, long term, recordings).

About typical categories of noise sources used in propagation models, the most common one was road traffic with 146 appearances. There was a smaller representation of railway noise, industrial noise, aircraft noise, leisure activities, and others. In 24% of the selection, the soundscape analysis included more than one type of sources.

Noise models are closely related to noise mapping, even if it is possible to draw interpolation maps only from measurements. Commercial software as Predictor-Lima, SoundPLAN, or Cadna A was cited in at least one third of cases. Besides that, 38% of all selected papers involved nationally developed tools, which can rely on the propagation standard approved.

The literature did not indicate that any particular standard takes an advantage over others. However, the implementation of CNOSSOS (Common Noise Assessment Methods in EU) could be expected to standardize practices in Europe.

2.4 Geographical comments

In geography, 2D renderings used in environmental noise are classified as thematic maps. A few criteria must be met to well design those and some rules shall be followed in order to deliver a message that is both accurate and illustrative of the reality. The representation, the choice of visual variables, the use of colors, the number of classes, and additional surrounding elements are related to the efficiency of the information reading. That was analyzed according to mapping characteristics such as:

a) Spatial resolution,
b) Map size (small scale to very large scale),
c) Map types (choropleth, isarithmic, chorochromatic, etc.),
d) Type of visual variables (color, hatch, marks, size),
e) Color progression (single hue, spectral, qualitative, etc.),
f) Clustering of results by ranges,
g) Map's parts (title, legend, frame, orientation, scale, etc.).

According to specialized geographers, the levels of compliance with the rules of graphic semiology and the general quality of chosen documents was made according to the criteria described above. A small proportion of the studies adopts a good (15%) or very good (2%) compliance. At the same time, only 13% of the maps were considered to be of good quality, and 1% of very good quality.

One interesting relation between geographic information sciences, geomatics, and acoustics is the description of topography. Digital ground models are getting very precise with modern technologies as LiDAR. This information can be transferred to noise modeling at some computational cost when the resolution is densified.

2.5 Next steps

The last part of the project focuses on the comparison of noise mapping design. Specialized commercial software is widely used by acoustical consultants. However, those kinds of tools can be expensive, and users must learn various details to get significant results. In Europe, open-source or low-cost software (iNoise) is more accessible or in development. For example, the NoiseModelling project [3] offers mapping results freely from an implementation of CNOSSOS standards and public data [4]. Things are not straight forward in Canada, as detailed traffic statistics are not publicly available or not shared in a global database.

3 Conclusion

In the end, 6 main categories of noise mapping methods were identified as found in Figure 2. The traditional method emerged as the most used method in more than 50% of the documents reviewed. Other methods showed some potential, such as land use regression models based on acoustic surveys.

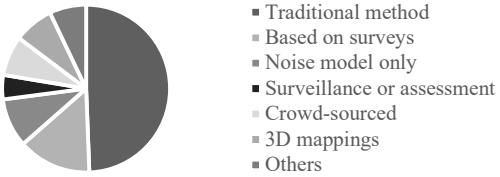

Figure 2: Classification of noise mapping methods in the review

The results from this scoping review led to the design of noise maps testing between 3 case studies. Final report shall help to get an easier access to input data required for noise modeling, and also a better understanding of those methods.

Acknowledgements

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