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SOME METHODOLOGICAL PERSPECTIVES OF USING GIS IN NOISE POLLUTION MAPPING

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The complex nature of mapping environmental noise pollution, the associated transmission paths and people's rather subjective perception of it seems to many people an impossible task. However, noise is rather specific, in that it tends to be a more localised issue, unlike air quality, which tends to be widely spreaded.

A European Union law initiative, (Directive on the Assessment and Management of Environmental Noise) soon to adopted, it is envisaged, requests that all member states carry out environmental noise mapping. The emphasis for environmental noise to be given the same priority status as other forms of pollution has come about by the increasing numbers of inhabitants being exposed to noise at levels detrimental to health or likely to give rise to annoyance, resulting from increased road, railway and aircraft traffic generated noise, and an increasing proportion of the population living in close proximity to these noise sources.

Many procedures have been formulated to calculate levels of noise from a number of sources, the majority of which relate to transportation modes, mainly roads, railways but also airports premises. Environmental noise, in most instances, consists of noise from a wide number of sources near and far, which, until recently, tended to be assessed independently. Localised factors, such as highly built-up areas causing reflections and urban canyon effects, and soft ground, can significantly affect noise levels at receptor locations (Borst H.C., 2001).

Noise mapping leads some way in bringing together the formulated procedures for each separate noise source, to give the overall noise "picture" at a particular location, although there is still need for further research and agreement on the methodologies to be adopted universally throughout Europe.

Noise mapping is considered to be a quantitative data gathering exercise and will, ultimately, be used to develop future noise policies/strategies to improve peoples' quality of life.

Urban and regional noise mapping is not a new concept, but has been routinely undertaken by noise consultants in countries like the Netherlands, U.K., France, Germany and Scandinavia which carried out noise mapping pilot studies.

Many commercially available noise mapping programs exist (NoiseMap 2000, Cadna A, LIMA and Sound Plan) and all promise to be the ideal tool. The common factor with all such systems is the combination of noise propagation calculations with a mapping and scheme editing facility, consisting of geo-referenced, three-dimensional input data, usually associated with Geographical Information

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Systems (GIS). GIS have been primarily used as a planning and management tool for all geo-referenced data. The interaction of the calculated acoustic parameters in association with GIS mapping systems results in a noise map (Carruthers D., Stocker J., Oates B.,2001).

The principal problems, having been highlighted by different European members' experience in noise mapping, is the compatibility and interaction of all the input data necessary to run the computer based models. Quite extensive digital data information is required and it is this that has caused some uncertainties. The availability of data and data from different sources has caused problems, along with the potential compatibility of the software tools used. Further difficulties consist of: large variability, in space and time, of the noise emissions; season dependence of many noise sources; noise propagation conditioned by topography, building environment, climate, absorption characteristics of the surrounding surfaces and ground etc.; cost and specialization of the means required for field measurements (Carvalho A., Rodrigues R., 2000; Psychas K., 2000; European Commission, 1998a; Office for Official Nordic Council of Ministers, 1994).

Methodology for sound field characterization

The main difficulty initially found that created the lead motif that identified the need for "acoustic scenarios", had to do with the lack of data reproducibility when acoustically characterizing an area. To make this characterization there are basically two main families of methods: The one associated to the spatial definitions of the measurements positions and that associated with the measurements duration in time. It is also possible to define a mixed methodology of these two following the specifics of a particular situation under study.

It is also frequent the use of another family of methods to characterize sound fields by the mathematical simulation done after noise source identification and characterization. In this case, dedicated software is usually used and has only particular interest in noise mapping of very limited areas because they require the knowledge of detailed information about all the noise sources (sound power etc.) that is not usually accessible.

To define the acoustic scenario a few measurement positions can be selected to make full measurements in order to understand the sound field behavior. The main conclusions of this phase have to do with the following aspects: several positions with large data correlation and other with very small correlation; data specifics related with the day of the week; large importance of the climate (rain, wind etc.); precise identification of the main sound sources (road transport noise, railway noise, aircraft noise, localized industrial, rural or commercial noise sources, season dependent activities: construction sites, fairs etc.); large similarity among "noise signatures" of similar zones.

This last conclusion, the presence of a large number of zones in which the noise parameters have similar behavior in one specific time period, pushed the

research for answers to the following questions: Is it possible to make a pattern for the ambient noise level characteristics in some zones by relation to other metrics or parameters than the ones measured? Is it possible to use socio-geographic data as maps, traffic counting data, industrial and demographic metrics, etc., to infer the ambient noise level behavior and therefore its acoustic zoning?

To be possible this methodology, the problem of characterizing very large sound fields should be simplified.

The use of indirect methods could lead to an economy of cost and time. In a second step, the use of digitized data could lead the way to the use of "acoustic" layers dedicated to noise zoning or noise planning (Carvalho A., Rodrigues R., 2000).

One main objective for the people engaged in the mapping is to develop working relations with local authorities. Through this, it is envisaged and anticipated that full co-operation and assistance will be provided by those local authorities having considerable knowledge of the source data required for the exercise, thus greatly assisting the fundamental data gathering process - a significant factor in the noise mapping.

Other goal is to develop a methodology to identify large sound field giving special attention to the results reliability and reproducibility as to the possibility to serve as a basis for an acoustical characterization of great areas (Carvalho A., Rodrigues R., 2000; Kunzmann K., 1997; WHO, 1997).

The initial study conclusions support that, an analysis at least on a municipal level, acoustic scenarios are clearly identifiable by the use of the following indirect parameters: population by groups of blocks of flats, presence of main roads crossing the groups of flats (need to characterize traffic volume data, which is time consuming), presence of industrial noise sources and average building height surrounding roads.

This holds true if there is only the need for noise zoning and not for noise mapping of precise noise level contour lines. These decisions can always be validated by sampling using field measurements, as far as the time and resources allow.

Also it is possible to classify large sound fields using other indirect methods using certain demographic data. Such a classification is more reliable if the only goal is to divide a large region in "noisy areas". It was found that is possible to make field measurements during time periods much smaller than conventional reference time periods, with very good results although this seems a fairly obvious conclusion to reach, it does point out the fact that if the objective of a noise mapping study is to pinpoint the worse affected areas, it my be unnecessary to consider, we can say, all the minor roads in an area where it is the main roads that are the main contributors to the noise problem (Carvalho A., Rodrigues R., 2000; Psychas K., 2000; Kunzmann K., 1997; WHO, 1997).

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