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Traffic noise mapping of the city of Santiago de Chile

E. Suárez *, J.L. Barros

Facultad de Ciencias de la Ingeniería, Instituto de Acústica, Universidad Austral de Chile, Valdivia, Chile

HIGHLIGHTS

- A traffic noise prediction model applicable to the reality of Chile has been selected.
- A simplified acoustic method for modeling buildings produces acceptable results.
- An official road classification can be used for traffic noise modeling.
- A noise map is developed using CadnaA software at low cost and with limited information for modeling.
- It has been observed that a significant percentage of the city' surface is affected by high noise levels.

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ABSTRACT

A noise map is a cartographic representation of the noise level distribution in a determined area and period of time. This article presents the most important aspects of the noise mapping project across Santiago, a city of nearly six million inhabitants. The study was performed employing limited information and a low-cost, vehicular traffic noise predictive model. The methodology applied to the Chilean experience can also be used to create noise maps for major cities. An evaluation of noise prediction models, considering simplifications of the modeling environment (buildings) and for the vehicular traffic flow rates attributed to the streets under study, was made. The noise levels were modeled according to recommended exposure values for the above area. The results revealed that the noise levels for the city of Santiago were high in a relevant percentage of the surface.

1. Introduction

Increasing traffic noise pollution in urban environments is a relevant problem in the framework of human health (WHO, 1999; OECD, 1991). The impact of noise exposure has been long investigated to develop noise maps in order to cope with its negative effects (Vogiatzis, 2012; Sommerhoff et al., 2004; Di et al, 2012). Many cities in the world have developed noise maps for different modeling areas, several noise sources and with varied outcomes. Since 2002, European cities are required to have a noise map to meet the Environmental Noise Directives and Regulations (EC, 2002; WG-AEN, 2007). In Chile, there is no such obligation; however, the Ministry of the Environment has been working since 1997 on a series of studies regarding this issue (Suárez et al., 2010; MMA, 2011a). Particularly, four relevant studies have been implemented in recent years: Phase I—Input Data Collection for Noise Prediction Model (CONAMA, 2008); Phase II—Noise Maps of Case Studies for the commune of Providencia and the city of Antofagasta (CONAMA, 2009); Phase III—Noise Map for the commune of Santiago (MMA, 2010); and Phase IV—Modeling of Santiago (MMA, 2011b). Studies related to Phases II, III and IV were conducted by the Institute of Acoustics at the University Austral of Chile.

To successfully implement noise control measures, it is first necessary to obtain information about the noise levels to which people are exposed. Some cities in Chile have developed noise maps for their urban areas, but most of them are diagnostic studies only involving noise level measurements; the cities that have been covered by this mapping include Santiago (1988, updated in 2001) (IRM, 1989), Castro (Suárez and Antillanca, 2005), Valdivia (Rey et al., 2011a, 2011b) and Puerto Montt (Suárez and Lobos, 2008). The difference with the noise map of Santiago is that this new map was performed by modeling and not by noise level measurements and considers a large area of study (the largest in the country to date, about 1000 km^2). One of the main challenges of the project was to develop a representative cost-effective noise map, given the limited cartographic and traffic flow information available.

* Corresponding author. Tel.: +56 63 221311.
E-mail address: enriquesuarez@uach.cl (E. Suárez).

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Fig. 1. Example of construction simplification. Partially occupied block is shown.

2. Methodology

The noise map was produced by the Computer Aided Noise Abatement (CadnaA) software, taking into consideration the methodology developed in previous projects (Álvarez and Suárez, 2008; CONAMA, 2009; MMA, 2010). The modeling software incorporated the necessary information, which relates mainly to cartographic data and traffic flow rates. It is important to note that this noise map is limited to the noise generated by vehicular traffic and does not include noise originating from planes, factories and other stationary sources, nor the neighborhood noise generated by the activity of people.

The experimental design considered an analysis of the input data available for modeling, i.e., the characteristics of the road network (roadway type, slope, number of lanes, number of vehicles, etc.), traffic flow, train flow, high-rise building developments, city blocks, urban land lots, meteorological variables and weekly traffic cycle, among others, besides the topography (contour lines) of the area.

The vehicular traffic flow and noise level were evaluated by studying 1,057 traffic flow measurements, which contemplated light vehicles, heavy motor vehicles and motorcycles. From these data, 721 are for off-peak times (09:00 to 18:00/20:00 to 21:00 h) and 336 at peak hours (07:00 to 09:00/18:00 to 20:00 h). A total of 305 of these also included acoustical measurements.

2.1. Modeling process

The noise map modeling was carried out by entering a series of data into the software and required various steps, which can be summarized as follows:

a) Define the traffic flow for each road or street: flow of light and heavy vehicles, speed, etc.
b) Set the modeling scenario: streets, buildings, contour lines, etc.
c) Choose the most appropriate prediction model.

Fig. 2. Zoning of the 34 municipalities of Santiago.