A NOISE MODEL FOR URBAN WATER TRAFFIC IN VENICE

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1 INTRODUCTION

Noise is considered among the first causes of urban degradation and the impact on human health and environment quality is huge. Many studies have demonstrated that urban noise exposure may produce a number of direct and indirect effects other than hearing damage. These include interference on communication and sleep disturbance effects.

In Venice, urban water traffic represents a consistent source of noise. All transport in Venice are water based, in particular on the canals that allow the passage of large motor boats and offer the most direct link between different parts of the city. The intensity of the traffic increases the acoustic discomfort of residents. The situation is worsened due to the small width of the canals and the close proximity of buildings that overlook them.

The Historic Centre is a very complex environment and many of the noise sources present on site have similar acoustic characteristics (vessels, water buses, private boats, hydrofoils and cruise ships). For these reasons it is really difficult to isolate the acoustic contributions of individual noise sources. The acoustic model produced with this research allows the identification of the contributions of different types of vessels to the overall ambient noise level and the formulation of different noise control strategies.

2 RESEARCH OBJECTIVES

The results of acoustic measurements contain contributions from background noise sources. To obtain noise measurements of water traffic only it is required that other sources are shut off; however, this is not always possible. Computational models for the prediction of urban noise originating from a number of different sources can offer some advantages. They give a greater level of detail in terms of frequency, source and receiver locations. Additionally, noise models are well suited as a planning tool and can provide flexibility for assessment of a variety of operational scenarios. Any requirements to update the model can be easily and quickly implemented. An extensive data collection (noise and geometry) is required to populate a noise model as well as higher acoustical skills. For stationary sources acoustic measurements to characterize the source can be achieved in a simple arrangement. For non-stationary sources it is not possible in practice to characterize each and all of the individual sources.

To develop a model of a “system” we must make assumptions about how it works. Numerical methods are based on analytical formulas that describe the physical phenomena related to the acoustic propagation starting from the source sound power data. The power spectrum of the noise sources can be obtained by means of noise measurements or by using available noise source databases.

A European database of industrial and port noise is available, as well as a software tool developed from DGMR, called “Source DB”, it contains information about sound power levels in docks site but it does not contain much information about sound power levels of boats. On-site noise measurements, using established techniques can be considered the most accurate option for the determination of sound power.

While there are specific technical standards to measure noise sources of traditional transportation, there is less information available about the acoustic characterization of water traffic noise. The specific objectives of this study are identified as follows:

- Complete acoustic characterization of boats and create a database of sound power levels for the main typologies of boats and Cruise Ship; and
- Implement an acoustic model to simulate water traffic noise in Venice.

3 LITERATURE SURVEY

Several studies about the sound power characterization of boats and cruise ships were carried out by ARPAV (Veneto Region Environment Agency) on behalf of Municipality of Venice, and by University of Padova on behalf of APV (Venice Port Authority). ARPAV performed acoustics measurements in high traffic canals of the Historic Centre of Venice (Rio Novo de Ca' Foscari, Rio de Cannaregio, Rio de la Sensa, Rio dei Santi Apostoli e Rio de la Pietà) and characterized some type of boats. They also carried out an in-depth study about water buses (ACTV) within the noise abatement plan of Venice.

University of Padova carried out studies about acoustic characterization and the mapping of moored cruise ships in Venice Port. Despite much excellent work on themes such as water traffic, the importance of an acoustic model for noise control has not yet fully explored. Yet, without such an understanding, we are left with an inadequate analysis that creates the condition for ill-informed policy decisions.

4 MATERIAL AND METHODS

As mentioned above to develop a model of a "system", it is important to acquire knowledge in terms of assumptions that usually take the form of mathematical and/or logical relationships. The main important factors affecting the noise generated by water traffic as a whole are traffic volume, composition of vessels in the traffic flow and traffic speed.

As a first step, a 3D model of Venice was developed; the digital ground model (DGM) and the digital building model (DGM) defined from cartography provided by Veneto Region.

In order to simulate different scenarios, the circulating park boats were divided into "acoustically" homogeneous groups. In Venice the transport of goods and passengers are carried out with different types of boats. Boats typology can be divided in five general classes according to their functions:

- Transportation related to public services, VESTA (transport of waste), postal service, emergency services (ambulances, fire, police force etc.);
- Public transportation of people (ACTV lines, taxi-lance, lance GT);
- Public transportation of goods (third party clients);
- Transportation of people and goods (on own account);
- Private transportation.

For each homogeneous category of boats acoustic measurements to characterize the sources were performed. For the allocation of flows traffic, references are the official schedule sheet of ACTV, the company that provides public transport services and some studies of COSES "Consortium for Research and Analysis". The transit of the Cruise Ships was analyzed with reference to the official annual time schedule of arrivals and departures.

The acoustic properties of any source can be usually defined in terms of source type (point, line, area) source height from the ground, sound power, and spatial distribution of the sound radiation (directivity). The boats were modelled as line noise sources at the height of 0.5 m from the level of the sea while the cruise ships were modelled as point noise sources at the height of 50 m from the level of the docks.

Noise calculations take into account propagation, reflection, diffraction, and attenuation of sound waves determined by the conformation of the territory and influenced by climatic conditions. The simulation of the noise propagation has been developed with reference to the ISO 9613-2 standard. Validation and calibration of the acoustic model were carried on through measurements on site.

Figure 1 – Transit of a big cruise ship in Canale of Scomenzera

5 RESULTS

The results of the study are as follow:

- A methodology to determine the sound power level of boats and cruise ship transiting on the canals;
- An acoustic database of water traffic, for different category of boats; and
- An acoustic model to simulate water traffic in Venice.

6 CONCLUSIONS

The control of environmental noise is based on a wide variety of strategies. Noise surveys are expensive and require a large investment of resources in equipment and manpower. Therefore, a great effort must be made to try and achieve the best compromise between the amount of resources expended and the reliability of the collected data in order to increase cost efficiency.

This project can be considered strategic for Venice policies on the environment noise. The acoustic model could be a useful resource for Authorities to verify the acoustic climate in the area. In the field of transport, as in other sectors, due to absence of appropriate communication among different public and private service providers, the active data grid is part in an open-loop system where a control center which gathers all the available information does not exist. A summary of the data obtained from information networks currently unconnected can help the survey of limits related to noise pollution.

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