

Modern tendencies in the use of ornamental trees and shrubs as sound - barrier

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Abstract

Transport networks are vital element in the nowadays European infrastructure. They connect people, boost economic activity and provide access to key services, but they also introduce barriers between natural areas as their use emits pollutants and introduces non-local species to ecosystems. Strong policy measures and a network of green spaces can help preserve and protect Europe's natural wealth.

Sofia city is connected to the rest of the country by an extensive transport network, comprising motorways, roads, rail tracks, cycle paths and flight routes. In addition to bringing goods and services to people, transport networks shape and impact the environment around them.

When the city has reached a certain level of connectivity, additional transport infrastructure does not provide additional benefits. It can, however, generate substantial environmental impacts. Transport networks can also facilitate the spread of urban areas and other built-up areas into relatively sparsely populated parts of Sofia city, exerting pressure on natural habitats. For example, connecting remote Vitosha Mountain to the transport system of Sofia city could attract more tourists to the area, resulting, for example, in a boost to accommodation and food-catering services. However, increased economic activity also often comes with the negative impacts on human settlements - more wastewater, more solid waste etc. Transport also leads to releases of pollutants, which can spread beyond the reach of transport networks. The pollutants can contribute to background concentrations of particulate matter, ozone and nitrogen dioxide, affecting people, plants and animals. The present work offers examination and overview on the methods for identifying the noise pollution in city areas and the tendency to introduce ornamental trees and shrubs as green sound barriers.

Keywords: noise pollution; plant noise barriers; transport and ecosystems

INTRODUCTION

Noise pollution from transport is a main concern

Construction of large transport projects, such as Sofia Ring Road, or large boulevards, can alter key characteristics of the urban ecosystem.

A 'green infrastructure' consists of a strategically planned network of high-quality green spaces with ornamental trees and shrubs. It requires a wider look at all green spaces - in remote urban and in central areas and connects between them. Bet-

ter connectivity is not the only positive outcome of green infrastructure and green barriers as a target. In addition to improving human health, it is increasingly seen as a cost-efficient way of reducing weather- and climate-related natural hazards.

Transport infrastructure projects, including those related to the Trans-European Network contribute to enhancing the quality of life across Sofia city, bringing services and public goods to remote parts.

The following methods are applicable for identifying the noise pollution in city areas:

- (1) Noise mapping by modeling and calculations;
- (2) Actual measurements of sound-pressure levels;
- (3) Evaluation of user/visitor experiences (i.e. the soundscape approach);
- (4) Expert assessments.

In this work the benefits and limitations of these methods are examined including the possibility for using ornamental trees and shrubs as sound barriers.

MATERIAL AND METHODS

Noise mapping

Noise maps provide an easily interpreted visual presentation of the distribution of calculated sound-pressure levels from given noise sources, such as traffic or industry in a given region, and for a defined period.

Noise maps are based on mathematical models of environmental noise emission and propagation outdoors, under given and restricted conditions.

Examples of factors that may influence the results are topography, weather, buildings, plants or other physical barriers, as well as façade and surface material. With this in mind, modeled noise maps are validated by actual measurements.

- Noise maps are typically based on one noise source at a time (road traffic, railway traffic, aircraft or industry).
- Noise maps do not include pleasant or preferred sounds, like wind in trees, purling water, birdsong or kid voice.
- Noise maps identify city areas based on calculated sound-pressure levels. One must keep in mind that an area which is undisturbed by environmental noise, for example a marshland, may not necessarily be valuable to human health when considering aspects other than environmental noise.

Measurement of sound-pressure levels

In many instances, the calculation models could not accurately predict the sound-pressure levels in courtyards enclosed by buildings.

Presently, most of the measurements cannot distinguish sound-pressure levels from different sources, nor measure environmental noise separately. The

actual measurement is a mixture of sound-pressure levels from various sources, including the sounds of the place: sounds of people, wind in vegetation and flowing water - environmental noise.

It is important to include additional criteria to that of sound-pressure levels. Such criteria may include land use plans, cultural heritage, ecological values, social and recreational values, and accessibility.

Perceived acoustic quality is not limited to the acoustic environment *per se*, but is also influenced by the visual quality of the area.

The lush green environment may increase perceived acoustic quality and reduce annoyance because the greenery has an influence on sound pressure levels.

RESULTS AND DISCUSSION

Data on perceived acoustic quality/appreciation in different city areas.

Figure 1 illustrates a model of relationship between sound-pressure levels and perceived acoustic quality.

Tables 1 and 2 present evidence that supports selection of noise barriers criteria based on sound-pressure levels in special points of measurements in Sofia city, based on Sofia city noise map.

Those criteria are:

Location

- Zone according to the master plan
- Hour
- Terrain
- Type of road floor
- Traffic - number of vehicles
- Type of vehicles
- Weather
- Season
- Before plant barrier
- After plant barrier
- Composition of the plant barrier
- Structure of the plantation
- Average height of vegetation
- Number of rows of tree vegetation
- Width of the plant barrier

This is summed up in Table 2, which highlights a number of studies on the effects of sound-pressure levels upon visitors to quiet areas.

Table 1. Selection criteria for quiet areas (not-limitative set)

Type	Indicator	Range criteria Urban (dB)	Range criteria Open country (dB)
Acoustic indicators	Leq, 24h	40	25–45
	Lden	50–55	-
	L50	-	35–45
	L90	-	30
	L95	30	-
	Lday	45–55	30–40
Functional	Recreation	Moderate intensive activity	Passive activity
	Nature protection	Moderate	Priority
	Health protection/ restoration	Health protection	Restoration priority
Distance	From motorway	-	4–15 km
	From agglomeration	-	1–4 km
Soundscape	Perceived acoustic quality/ appreciation	-	-
Size	-	100–100 000 m ²	0.1–100 km ²
Visual	Areas with established values in official documents, e.g. land use plans or nature conservation plans		

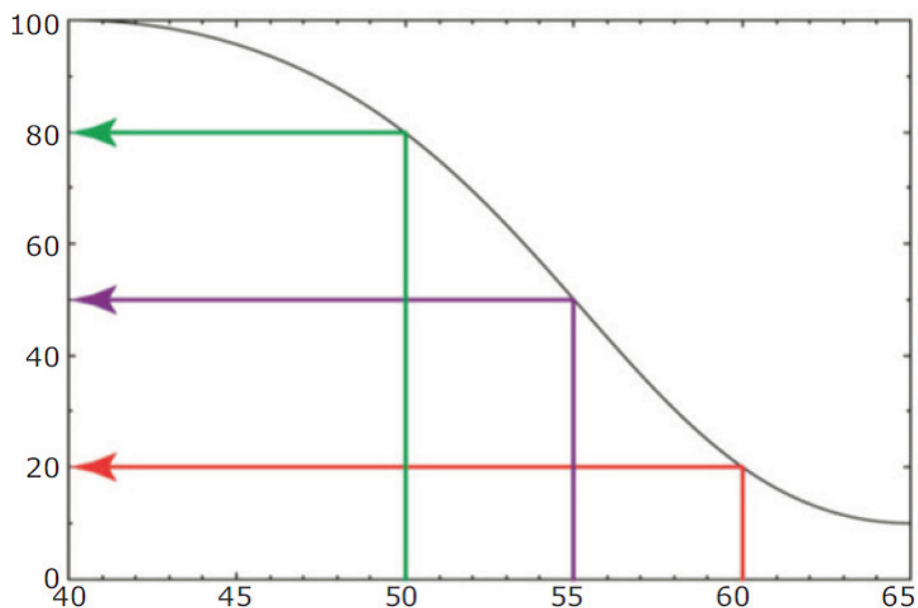


Figure 1. Equivalent continuous sound-pressure level (dB (A)).
Source: Adapted from Nilsson, 2010b.

Table 2. Sound-pressure levels related to perceived acoustic quality/appreciation

Sound-pressure levels (LAeq, Lday)	Perceived acoustic quality/appreciation (a)
< 45 dB	~ 100% of visitors perceive acoustic quality as good
45–55 dB	~ 50% of visitors perceive acoustic quality as good
> 55 dB	% of visitors perceiving acoustic quality as good falling rapidly with rising sound-pressure levels

Note: Besides sound-pressure levels, the score depends on other area qualities (e.g. visual quality, air quality and perceived types of sounds: human, nature and technology)

Health benefits of creating green barriers from ornamental trees and shrubs

People living in quiet areas do not suffer the negative health effects, which befall those exposed to the average sound-pressure levels in an agglomeration; quiet areas also benefit the health and well-being of regular visitors. For example, there is some evidence for annoyance and restoration, as indicated below.

- Access to the quiet side of a residence (i.e. LAeq, 24h < 45 dB) reduces annoyance. Also, nearby quiet zones in noisy areas seem to reduce annoyance. In fact, mere access to nearby green areas seems to improve well-being (Öhrström, et al., 2006; Gidlöf-Gunnarsson & Öhrström, 2007).

- People recover faster in natural surroundings, an effect that seems applicable to quietness and natural sounds as well (Alvarsson et al., 2010).

- Among residents in Amsterdam, 75 % indicate that quiet around the house is important, and 50 % state that quiet in the neighborhood is important (Van den Berg & Booi, 2012).

- In the Netherlands, 46 % of the population consider their neighborhoods to be ‘not quiet’. Half of the population visit quiet places in the neighborhood daily or weekly (Van den Berg & Booi, 2012).

- In the United Kingdom, 91 % of the population believe that existing areas of quiet must be protected. In London, the corresponding figure is 62 % (NSCA, 2007) (EEA, 2014. Technical report No 4/2014).

Among residents in Sofia, 85% indicate that quiet neighborhood is important, EAO, 2015 (European environment – state and outlook 2015. European environment agency - report. Copenhagen).

Biodiversity effects of ornamental plants as a modern tendency in an approach of city planning

In the modern trends in the design of green areas, an attention should be paid on the environmental noise caused by human intervention. The use of ornamental plants is an effective solution for reducing the increased levels of traffic noise in urban and non-urban city areas.

The contemporary design of noise barriers should be developed in the direction of efficiency, ecology and aesthetics. The transport arteries, which are the connection between the residential areas and the city center, represent an important structural element of the planning of the settlements and the same time determines the general architectural appearance. In recent years, the issue of urban development is particularly relevant. The creation of efficient solutions for the design of the extra-green green sound insulating environment – the road from the road to the facades of buildings, which includes pedestrian traffic, resting areas, and operational areas through ornamental vegetation, is a basic method for aestheticization of the environment and development priority.

Biodiversity benefits city areas as nature sounds are generally valued positively by visitors to a place, and also contemporary design creating more green areas will serve as reducing of traffic noise as noise barrier from ornamental trees and shrubs.

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