Reduction of Traffic Noise Pollution Effects by Using Vegetation, Turkey’ Sample

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Abstract

It is a well-known fact in all societies worldwide that noise is a serious environmental pollutant. In this paper, negative effects resulting from exposure to noise pollution on people’s well-being is reviewed in the light of the previous published studies. First, noise is generally defined, subsequently, in order to clarify the subject, noise pollution types, negative effects of noise on human’s health and attenuation methods of noise pollution are discussed. In conclusion previous studies about the topic of ‘the mitigation of the noise pollution effects by using vegetation’ in Turkey are reviewed to explain the reduction methods of the noise pollution by vegetation and to refer to its aesthetical, ecological, etc. advantages, excluding its noise barrier function. Considering the negative effects of the noise pollution, the findings of this study are important at both individual and social level and could be helpful as a guidance for planning of the areas which have the potential of the noise pollution effects.

Keywords: Noise, Noise pollution, Reduction of noise, Vegetation

Introduction

Environmental pollution becomes more severe and widespread due to population growth, urbanization and industrialization in the cities (Ralte et al. 2013; Özdemir et al., 2014). Migration
of people from rural to urban areas, expansion of cities, infrastructure development, population growth and urbanization are important factors resulting in motorization and consequent increase in levels of various urban pollution (Mishra, R. K., Parida, M., & Rangnekar, S., 2010). There are many factors which cause the environmental pollution and one of those undesired and unpleasant factors is ‘noise’ which affects the quality of life of life as it interferes in the activities of an individual like concentration, communication, relaxation and sleep (Haq, T. H., Farooq, H., & Ahmad, M. R., 2014).

Noise pollution (after air and water pollution) is considered to be the third most serious kind of pollution in metropolises, by the World Health Organization (WHO). The WHO recently estimated that traffic noise could conservatively account for over one million health years of life lost annually in the European Union and Western European countries (Mishra et al., 2010).

With increase of pollution and means of transportation and the development of industries, the range of noise pollution and unwanted noises have increased greatly (Maleki & Hosseini, 2011).

Noise pollution is an environmental problem which is more densely seen along the main arteries of a city. The WHO recently estimated that traffic noise could conservatively account for over one million health years of life lost annually in the European Union and Western European countries.

As a result, in metropolises, noise pollution (after air and water pollution) is considered to be the third most serious kind of pollution by the WHO (Anonymous, 2012). Robert in the 19th century has stated that the most important problem of human beings in the next century is not infectious diseases but noise pollution (Cowan, 1994).
When green spaces are sufficient, the reduction of noise by plants has great importance in the urban ecosystems (Çepel, 1994; Rao et al., 2004; Fang & Ling 2005).

**Negative Effects Of Noise On Health**

Numerous researchers have demonstrated that exposure to environmental noise may increase the risks related to personal health, such as nervous frailty, extreme irritability, muscle cramps, stress and anxiety, dizziness, headache and migraine, anger, loss of body balance.

No matter what the level or the exposure period is, the noise has significant effects on human health (Anonymous, 2011). The effects of noise on human health studied in four groups:

- **Physical effects**: (temporary or permanent hearing loss),
- **Physiology effects**: (difficulty in breathing, heart beating disorders, the increase of blood pressure, gastrointestinal circulatory disorders, sleep disturbances, irregularity in blood sugar, ulcer, asthma, hyperthyroidism as effect clinical symptoms),
- **Psychological effects**: (adverse emotions including anger, disappointment, anxiety, and depression behavioral disorders, difficulty in concentration),
- **Performance effects**: (drop of reading, learning and work performance, lack of concentration, prevent movements)

Noise degrades the quality of life by affecting physical as well as mental status of person (Babisch, 2006). As reported by Mishra et al. (2010) from Koh & Jeyaratnam and Uimonen et al., a number of acute and chronic effects on humans are found due to exposure to traffic noise. It can cause disturbance in sleep, annoyance, mental disorders, hearing loss, and adverse physiological and psychological impacts (Miller, 1998). Agrawal and Swami, (2009) examined the noise pollution problem in urban areas due to rapid developing motor vehicles.
Investigations have revealed that an individual can tolerate a certain amount of noise pollution in his or her lifetime. But noise pollution has many detrimental effects on human beings, both mentally and physically (Maleki & Hosseini, 2011).

In 1993, the World Health Organization (WHO) recognized the following effects on the health of the population that can emanate from noise: sleep patterns, cardio respiratory and psycho physiological systems, and hearing. It also affects us negatively on intervention in communication, productivity and social behavior (Samara & Tsitsoni, 2007).

**Noise Pollution and Types**

Noise is defined as unwanted sound. Noise that is perceived as a detriment to our quality of life due to its intensity, timing, duration and/or its source is defined as noise pollution. Noise comes from various sources. To understand noise we must understand the different types of noise, where noise comes from, the effect of noise on humans and the various ways we have of measuring both the sound as a cause of noise and the noise effects.

People activities are generally noise sources. Berglund and Lindvall (1995) explained the noise in six sections:

- **Machinery Noise, Noise from Industrial Plants and Ventilation System Noise**: Noise from Industrial Plants and Mechanized industry creates serious noise problems, subjecting a significant fraction of the working population to potentially harmful sound pressure levels of noise. It is responsible for high noise emissions indoors as well as outdoor of plants.

- **Transportation Noise**: Road traffic, rail traffic, air traffic and sonic booms. Due to the fact that traffic noise is affecting a wide group of people and this situation commonly show itself in all cities, the road transport noise has a particular importance.
-Construction Noise, Public Works Noise and Military Noise: Building construction and earth works are activities that can cause considerable noise emissions.

-Building Services Noise: Building service noise can affect people both inside and outside the building.

-Domestic Noise: Noise from neighbors is often one of the main causes of noise complaints.

-Noise from Leisure Activities: The possibilities of using powered machines in leisure activities are increasing all the time.

Traffic Noise

The biggest source of noise in cities is vehicles and road traffic, forcing residents to escape the clamorous roadsides and take refuge in quieter spots.

One of the most crucial noise type is urban traffic noise and naturally it is considered more interfering than the other types of noises (Zannin et al., 2003; Mishra et al., 2010).

In recent years, road traffic noise has played a dominant role in environmental noise pollution, which can have negative effects on communities’ health. (Chepesiuk, 2005; Bluhm et al., 2007; Mehdi et al., 2011).

Traffic noise generates from a mixture of different vehicles, light and heavy, running in the streets of a city or in the different lanes of a highway. Cars are invading the urban landscape more and more, contributing to a higher level of noise pollution than any other man-powered engine. Therefore, most of today's research on noise control is focused on noise from transportation with special emphasis on that of urban traffic (Ouis, 2001).

Mishra et al., (2010) found on the basis of their survey, 68 % people reported the problem of stress due to traffic noise pollution.

The Materials Using In Reduction of Noise
As more lanes are added and some new roads are constructed, increased traffic generates more noise that creates demands for noise attenuation or abatement measures such as:

• The construction of barriers/walls or raised berms.
• The provision of landscaping/vegetation.
• The provision of acoustical design techniques (Anonymous, 2005).

According to other materials, plant usage in noise reduction has many advantages.

- Improves air quality,
- Creates a natural ecosystem in the city,
- Improves the environmental conditions in terms of both quality and esthetically
- Has a positive psychological effects,
- Prevents erosion,
- Improves the quality of the soil by providing organic material,
- Has a functional feature like traffic arrangement and orientation.

Instead disadvantages could be explained as follows.

- According to structural materials, plant materials occupy more space.
- Maintenance works (labor, pruning, spraying, etc.) can sometimes be more expensive.

The establishment principles of plant belts

Reduction of noise with plants when sufficient area is provided in the urban ecosystems is of great importance. The principles which are needed to be successful in establish of a noise belt area could be summarize such as in the following:
- The minimum planting area should be 5m width. This amount could be as much as far up to 30m.

- The plants which are subjected to use should be selected from natural flora or the appropriate varieties which are compatible with the natural flora.

- The “evergreen” plants should be used primarily.

- The plants should be planted uprightly to the noise direction.

- The plants should planted closely as possible as to each other and the distance between two plants should be appropriate with growing conditions.

- The plants which are longer, bigger, hard textured, intensive leaf-branch and apical tissue which is reaching to the ground should be preferred.

- The plant groups which are consisted from different heights of trees, shrubs and bushes should be used.

- The longer plants should be planted to the back side of shorter plants, and the distance between to plants should be increase as much as possible. The plants consisted from bushes and coniferous which are more than 5m are able to more blocking to the noise.

- The result would be better in case of the a position where the plant belt placed as much as close to the source of the noise and as much as far to the area which is wanted to be protected.

- It is going to be more efficient that putting the plant belts together with noise barrier wall and soil wall to blocking the noise (Onder & Kocbeker, 2012).

Previous International Studies

Noise pollution is recognized as a major problem for the quality of life in worldwide urban areas by now.

Turkey has been experiencing an economical improvement since 1980s. Consequently increasing industrialization and urbanization naturally caused to the occurrence of noise pollution. Noise prevention studies are also increased accordingly. Contrary to increase of the studies in this topic after 1970 in the world, in Turkey, a few studies pointed out this issue, since 1990. Studies in Turkey on ‘the reduction of traffic noise by using vegetation’ are given in Table 1. Nevertheless, according to years and regions, studies have been conducted on the traffic noise (or relevant topics) in the Ministry of Environment and Urbanization (Anonymous 2010) and the projects and thesis made by different universities and research institutes (Karadayi 2001, Aktaş 2002, Hoçanlı 2004, Kalıpçı 2007, Ünver 2008, Celik 2009, Akça 2009, Oztürk 2010, Toklu 2011, Morgül & Dal 2012, Yerli 2012, Paşaoğlu 2013, Demir 2013).

<table>
<thead>
<tr>
<th>STUDY NAME</th>
<th>PLANT SPECIES</th>
<th>PLANTATION WIDTH</th>
<th>DISTANCE TO SOUND SOURCE</th>
<th>NOISE REDUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erol, 1993</td>
<td><em>Forsythia intermedia</em></td>
<td>1 row</td>
<td>1 m</td>
<td>2 dB(A)</td>
</tr>
<tr>
<td></td>
<td><em>Forsythia intermedia</em></td>
<td>1 row</td>
<td>2 m</td>
<td>3 dB(A)</td>
</tr>
<tr>
<td></td>
<td><em>Thuja orientalis</em></td>
<td>2 row</td>
<td>1 m</td>
<td>2 dB(A)</td>
</tr>
<tr>
<td></td>
<td><em>Thuja orientalis</em></td>
<td>2 row</td>
<td>2 m</td>
<td>4 dB(A)</td>
</tr>
<tr>
<td>Species Combination</td>
<td>Rows</td>
<td>Distance</td>
<td>Noise Reduction</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
<td>----------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>Pyracantha coccineae</td>
<td>2</td>
<td>1 m</td>
<td>2 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pyracantha coccineae</td>
<td>2</td>
<td>2 m</td>
<td>3 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Syringa vulgaris</td>
<td>2</td>
<td>1 m</td>
<td>1 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Syringa vulgaris</td>
<td>2</td>
<td>2 m</td>
<td>2 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Cornus alba sibirica</td>
<td>2</td>
<td>1 m</td>
<td>2 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Cornus alba sibirica</td>
<td>2</td>
<td>2 m</td>
<td>3 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pyracantha coccineae + Syringa vulgaris</td>
<td>4</td>
<td>1 m</td>
<td>4 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pyracantha coccineae + Syringa vulgaris</td>
<td>4</td>
<td>2 m</td>
<td>5 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Cornus alba sibirica + Syringa vulgaris</td>
<td>4</td>
<td>1 m</td>
<td>3 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Cornus alba sibirica + Syringa vulgaris</td>
<td>4</td>
<td>2 m</td>
<td>4 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pittosporum tobira + Prunus laurocerasus + Cupressus atlantica cv. Glauca</td>
<td>3</td>
<td>6 m</td>
<td>5 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Illicium anisatum</td>
<td></td>
<td>6 m</td>
<td>3,6,10 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pinus sylvestris L.</td>
<td>25 m</td>
<td></td>
<td>9,3 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pinus sylvestris L.</td>
<td>50 m</td>
<td></td>
<td>5,3 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pinus sylvestris L.</td>
<td>75 m</td>
<td></td>
<td>5,7 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Populus nigra L.</td>
<td>25 m</td>
<td></td>
<td>3 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Populus nigra L.</td>
<td>50 m</td>
<td></td>
<td>2,5 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Populus nigra L.</td>
<td>75 m</td>
<td></td>
<td>2,4 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Berberis thunbergii + Cotoneaster dammeri</td>
<td>5 m</td>
<td>1 m</td>
<td>4,8 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Berberis thunbergii + Euonymus japonica</td>
<td>5 m</td>
<td>1 m</td>
<td>3,7 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Berberis thunbergii + Pyracantha coccinea</td>
<td>5 m</td>
<td>1 m</td>
<td>6,3 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Forsythia intermedia + Pyracantha coccinea + Juniperus horizontalis</td>
<td>5 m</td>
<td>1 m</td>
<td>6 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Spiraea vanhouettii + Cotoneaster dammerii</td>
<td>9 m</td>
<td>1 m</td>
<td>2,7 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Spiraea vanhouettii + Cotoneaster dammerii + Pyracantha coccinea</td>
<td>9 m</td>
<td>1 m</td>
<td>5,5 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Forsythia intermedia - Juniperus horizontalis</td>
<td>9 m</td>
<td>1 m</td>
<td>4,9 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pyracantha coccinea + Juniperus horizontalis</td>
<td>20 m</td>
<td>1 m</td>
<td>3,5 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pyracantha coccinea + Juniperus horizontalis</td>
<td>20 m</td>
<td>1 m</td>
<td>3,9 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Cotoneaster dammerii + Juniperus horizontalis + Spiraea vanhouettii</td>
<td>20 m</td>
<td>1 m</td>
<td>6,2 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pyracantha coccinea + Cotoneaster dammeri</td>
<td>20 m</td>
<td>1 m</td>
<td>5,1 dB(A)</td>
<td></td>
</tr>
<tr>
<td>Pyracantha coccinea + Forsythia intermedia + Tamarix tetrandra</td>
<td>20 m</td>
<td>1 m</td>
<td>4,9 dB(A)</td>
<td></td>
</tr>
</tbody>
</table>

**Results**

In this study, the studies related with the reduction of traffic noise by vegetation in Turkey were reviewed.
Noise which has been defined as the unwanted noise being made up of sound waves which are not sinusoid, particularly affect and disturb people depending on the intensity, spectrum frequency and the period. Noise is a problem that affects everybody. Noise is likely to continue as a major issue well into the next century.

There are two types of barriers which prevent noise pollution in place: Synthetic barriers (concrete, stone, wood, and the paravanes which are made by metal and transparent plastics) and living elements (the plant belts which are formed by trees and bushes). Because of their known other benefits (aesthetic, functional, climate improvement, providing moisture, prevention of erosion and etc.), vegetation should be preferred to mitigate traffic noise, if appropriate areas and adequate maintenance facilities exists.

Green space establishment techniques should be in accordance with scientific methods and the diversity of plant species appropriate to the local ecology should be increased in terms of both quality and quantity.

Due to the positive effects on human and environmental health, it is clear that the efforts made to increase the number of studies on this topic will be very useful.

References


