International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:6, No:6, 2012

Importance of the Green Belts to Reduce Noise Pollution and Determination of Roadside Noise Reduction Effectiveness of Bushes in Konya, Turkey

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***Abstract*—**The impact of noise upon live quality has become an important aspect to make both urban and environmental policy-throughout Europe and in Turkey. Concern over the quality of urban environments, including noise levels and declining quality of green space, is over the past decade with increasing emphasis on designing livable and sustainable communities. According to the World Health Organization, noise pollution is the third most hazardous environmental type of pollution which proceeded by only air (gas emission) and water pollution. The research carried out in two phases, the first stage of the research noise and plant types providing the suction of noise was evaluated through literature study and at the second stage, definite types (Juniperus horizontalis L., Spirea vanhouetti Briot., Cotoneaster dammerii C.K., Berberis thunbergii D.C., Pyracantha coccinea M. etc.) were selected for the city of Konya. Trials were conducted on the highway of Konya. The biggest value of noise reduction was 6.3 dB(A), 4.9 dB(A), 6.2 dB(A) value with compared to the control which includes the group that formed by the bushes at the distance of 7m, 11m, 20m from the source and 5m, 9m, 20m of plant width, respectively. In this paper, definitions regarding to noise and its sources were made and the precautions were taken against to noise that mentioned earlier with the adverse effects of noise. Plantation design approaches and suggestions concerning to the diversity to be used, which are peculiar to roadside, were developed to discuss the role and the function of plant material to reduce the noise of the traffic.

***Keywords*—**Bushes, noise, road, Konya

I. Introduction

IT is known that 70% of the world's urban population lives in developing countries [1]. The increasing population and improving technology have brought about changes in the economic and social structure of societies in the counties like Turkey. Much of these urban populations are vulnerable to the ill health effects of noise. Despite being a less frequently considered type of environmental pollution; noise has a major negative impact on the quality of life in cities. Especially dense transportation systems, including roads, railways, and air traffic, characterize the modern urban environment. These systems have caused environmental noise (also known as community noise) pollution [2,3].

Many studies have been conducted to reduce the noise levels and its negative effects in various countries all over the world [4-10]. The acoustical effect of a belt of trees/vegetation near roads has been a popular research topic over the past 40 years [13-24].

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In the present research, the relative literature and the similar researches which were made previously in Konya to determine the reducing effect of plant belts were evaluated [25]. Suggestions were given which are supposed to take care by plant precautions to block the noise on the roads.

II. Noise, Its Effects And Precautions

The purpose of Noise Control Regulation which has been prepared on the basis of Turkish Environmental Law is to ensure the development of an environment which won't impair the peace, silence, physical and mental health with noise and in harmony with this purpose to determine the limits to put the noise control into effect by means of the definition of the terms related to noise. In the first part of Noise Regulation, noise is defined as a sound with an irregular structure [26].

The sources forming the noise are generally classified into three groups as:

-Noise arising from industry (factory, workshop etc.)

-City/settlement noise (sports fields, open market places, children, and playgrounds, parks, fairs, outdoor concert venues, school gardens etc.)

-Traffic/transportation noise (air transport, maritime transport, rail and road transport etc.).

No matter what the level or the exposure period is, the noise has significant effects on human health [27]. The impact 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 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)

In the researches carried out in relation to the noise four noise stages have been determined, making a general classification. According to this classification:

-The noise between 30 and 65 dBA: 30 dBA is generally the noise level inside and outside at which people do not feel disturbed as long as the period doesn't get longer. Yet, 45 - 65 dBA is a level at which concentration disorder, unwillingness to work, etc. may appear.

-The noise between 65 - 95 dBA: At this noise level, psychological disorders may appear in people as the period gets longer.

-The noise between 90 - 120 dBA: The noise at this level causes problems in hearing organs as well as psychological disorders. As the existence period in mediums with over 100 dBA gets longer permanent hearing losses start to appear.

-The noise over 120 dBA: The noise at this level has negative effects not only on humans but also on a number of living things.

The precautions against to noise could be explained by the following items [28]:

-Decreasing the noise on the source

-Decreasing the noise on the spread area

-Taking measures on the point where the noise is detected.

There are two main reasons which are both decrease and increase the noise:

-Distance between the source of the noise and receiver: Increasing of the distance between source and receiver cause to decreasing on the perception of the noise

-Barrier between the source of the noise and receiver:

a. The barriers which are consisted by synthetic barriers: Concrete, stone, wood, and the paravanes which are made by metal and transparent plastics

b. The barriers which are consisted by living elements: The plant belts which are formed by trees and bushes [29].

Besides the fact that plant material practices aiming at preventing traffic noise are economically more suitable when compared to nonliving materials such as concrete wall, plastic plate, they should also be preferred due to the fact that they will contribute to the environment aesthetically with the properties of colour and shape changing depending on the season [30].

The list of benefits provided by road trees is long and diverse [31].

Street trees protect pedestrians from the sun and the rain, and provide critical spaces and shelter for street vendors. While street trees may constitute only a small fraction of green cover in most cities, wooded streets constitute the most accessible green spaces for the vast majority of low to medium income city dwellers who lack access to other green spaces in residential and commercial areas [32], thus playing an extremely significant and irreplaceable role in urban lives. Other, significant ecological and environmental benefits are provided by street trees. Wooded streets constitute important habitats for birds and other urban taxa in urban landscapes, and provide critical landscape connectivity by acting as corridors between urban parks [33]. Street trees and other urban trees play a significant role in lowering urban temperatures and mitigating the intensity of urban heat island effects [34], thereby providing significant savings in electricity [35-36]. These trees help in reducing storm water runoff, thus reducing the likelihood of flooding and damage to urban properties. They act as noise filters, purify air and sequester carbon [35-37].

III. The İmportance of Plants İn Reducing Roadside Noise Problem: Konya Case

Vegetation has been proposed as a natural material to reduce noise energy outdoors. Belts of trees and bushes situated between the noise source and the receiver can reduce the noise level perceived by the receiver [13-38]. A number of studies have examined the acoustic performance of vegetation in reducing noise [30, 38-46].

The previously researches which were made in Konya were reported that the noise which is derived from traffic had been reached to the level of important dimensions [47-48].

The plant groups which were consisted from *Pyracantha coccinea* M., *Cotoneaster horizontalis* Decne., *Berberis thunbergii* D.C., *Cotoneaster dammeri* C.K., *Forsythia intermedia* Zab., *Juniperus horizontalis* L., *Spirea vanhouetti* Briot., *Tamarix tetranda* L., *Euonymus japonica* L. were used in a width of 5m, 9m and 20m to determination of decreasing effect on the noise in Konya. The results of the measurements were given in Table I.

TABLE I
NOISE MEASUREMENTS AND NOISE REDUCTION VALUES OF PLANTS

Ist Group	*Plant species Measuring distance (7m)*	*Measurement dB(A)*	*Decreasing dB(A)*
1st Measure	No vegetation (control area)	72	
2nd Measure	*Berberis thujnbergii - Cotoneaster dammeri*	67,2	4,8
3rd Measure	*Berberis thujnbergii - Euonymus japonica*	68,3	3,7
4th Measure	*Berberis thujnbergii - Pyracantha coccinea*	65,7	6,3
5th Measure	*Forsythia intermedia - Pyracantha coccinea - Juniperus horizontalis*	66	6
IInd Group	*Plant species Measuring distance (11 m)*	*Measurement dB(A)*	*Decreasing dB(A)*
1st Measure	No vegetation (control area)	65,1	
2nd Measure	*Spiraea vanhouetti - Cotoneaster dammerii*	62,4	2,7
3rd Measure	*Spiraea vanhouetti - Cotoneaster dammerii- Pyracantha coccinea*	56,6	5,5
4th Measure	*Forsythia intermedia - Juniperus horizontalis*	60,2	4,9
IIIrd Group	*Plant species Measuring distance (22 m)*	*Measurement dB(A)*	*Decreasing dB(A)*
1st Measure	No vegetation (control area)	59,8	
2nd Measure	*Pyracantha coccinea - Juniperus horizontalis - Cotoneaster horizontalis*	56,3	3,5
3rd Measure	*Pyracantha coccinea - Juniperus horizontalis*	55,9	3,9
4th Measure	*Cotoneaster dammerii - Juniperus horizontalis - Spiraea vanhouetti*	53,6	6,2
5th Measure	*Pyracantha coccinea - Cotoneaster dammeri*	54,7	5,1
6th Measure	*Pyracantha coccinea - Forsythia intermedia - Tamarix tetranda*	54,9	4,9

IV. Conclusion

In recent years, road traffic has played a dominant role in causing environmental noise, which can have ill effects on communities [49-50]. 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 planting area should be a total of 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 should be used

-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 betwwen 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 beter 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.

REFERENCES

[1] Cohen, B., 2006. Urbanization in developing countries: current trends, future projections, and key challenges for sustainability. Technol Soc 2006;28:63–80.

[2] McMichael AJ., 2000. The urban environment and health in a world of increasing globalization: issues for developing countries. BullWorld Health Organ 2000;78(9):1117–26.

[3] Moudon, AV. and Wee BV., 2009. Environmental effects of urban traffic. In: Garling T, Steg L, editors. Threats from car traffic to the quality of urban life: problems, causes, and solutions. Amsterdam, Netherlands: Elsevier; 2007. p. 11–32.

[4] Sy, HK., Ong, PP., Tang, SH. and Tan, KL., 1985. Traffic noise survey and analysis in Singapore. Applied Acustics, 18(2), 15–125.

[5] Garcia, A., 1997. Noise survey in the community of Valencia (Spain). Acustica, 839(3), 516–521.

[6] Arana, M. and Garcia, A., 1998. A social survey on the effects on environmental noise pollution in the city of Curitiba, Brazil. Applied Acoustics, 53, 245–253.

[7] Onuu, MU. 2000. Road traffic noise in Nigeria.Measurements, analysis and evaluation of nuisance. Journal of Sound and Vibration, 233(4), 391–405.

[8] Zannin, PH., Zanin, FB. and Barbosa, W. A., 2002. Environmental noise pollution in the city of Curitiba, Brazil. Applied Acoustic, 63, 351–358.

[9] Li, B., Tao, S. and Dawson, R.W., 2002. Evaluation and analysis of traffic noise from the main urban roads in Beijing. Applied Acoustics, 63(10), 1137–1142, October.

[10] Morillas, JMB., Escobar, VG., Sierra, JAM., Gómez, RV. and Carmona, JT., 2002. An environmental noise study in the city of Cáceres, Spain. Applied Acoustics, 63 (10), 1061–1070, October.

[11] Gunnarsson AG, Ohrstrom E., 2007. Noise and well-being in urban residential environments: The potential role of perceived availability to nearby green areas. Landscape and Urban Planning 83:115–126.

[12] Mishra RK, Parida M. and Rangnekarınt S., 2010. Evaluation and analysis of traffic noise along bus rapid transit system corridor. J. Environ. Sci. Tech., 7 (4):737-750.

[13] Aylor DE, 1972. Noise reduction by vegetation and ground. J. Acoust. Soc. Am. 51, 197–205.

[14] Whitcomb, C. and Stowers, J., 1974. Stop noise with hedges. Horticulture, 2(4), 58–67.

[15] Lorenz, E., 1975. Karayolları Ağaçlandırma Rehberi (Çeviren F. Tanrıverdi) Karayolları Genel Müdürlüğü Matbaası. Yayın, 214, 55, Ankara.

[16] Cook, DI. and Haverbeke, DF., 1977. Suburbon noise control with planting and solid barrier combinations Research bulletin p. 100. Lincoln: EM.

[17] Krag, J., 1979. Pilot study on railway noise attenuation by belts of trees. Journal of Sound and Vibration, 66(3), 407–415.

[18] Çepel, N., 1994. Landscape Ecology’ I.U. Forest Faculty, Puplished No. 429, 228, İstanbul.

[19] Pal A., Kumar V. And Saxena N., 2000. Noise attenuation by greenbelts, Journal of Soundand Vibration 234 (2000)149–165.

[20] Rao, PS., Gavane, AG., Ankam, SS., Ansari, MF., Pandit, IV., and Nema, P., 2004. Performance evaluation of a green belt in a petroleum refinery: A case study. Ecological Engineering, 23(2), 77–84.

[21] Fang CF. and Ling DL, 2003. Investigation of the noise reduction provided by tree belts. Landscape and Urban Planning 63:187–195.

[22] Fang, CF. and Ling, DL., 2005. Guidance for noise reduction provided by tree belts. Landscape and Urban Planning, 71 (1), 29–34.

[23] Tyagi V., Kumar K. and Jain V., 2006. A study of the spectral characteristics of traffic noise attenuation by vegetation belts in Delhi, Applied Acoustics 67 (2006) 926–935.

[24] Pathak V., Tripathi B., Mishra V., 2008. Dynamicsof traffic noise in a tropical city Varanasi and its abatement through vegetation, Environmental Monitoring and Assessment 146 (2008) 67–75.

[25] Koçbeker Z. and Onder S. 2012. Investigation of the Noise Reduction Provided by Bush Belts in Konya, Turkey. J. Int. Environmental Application & Sciences, Vol. 7(1):48-54.

[26] Anonymous 1999. The Turkish environmental legislation. the publication of Environment Foundation of Turkey. Publication no:134. Onder printing, Ankara.

[27] Anonymous 2012. World Health Organization, Burden of Disease from Environmental Noise. Available at:http://docs.wind-watch.org/WHO-burden-of-disease-from-environmental-noise-2011.pdf 2011. Accessed Feb. 10, 2012.

[28] Sarıgül, S., 1995. CED Kapsamında Ses ve Gürültü Kirlenmesi. D.E.Ü. Çevre Araştırma ve Uygulama Merkezi ve TMMOB Çevre Mühendisleri Odası İzmir Şubesi. İzmir.

[29] Gür, K. and Onder, S. 2000. Konya'da Gürültü Kirliliği ve Alınması Gereken Biyolojik Önlemler. 3. GAP Mühendislik Kongresi. 24–26 Mayıs 2000 s: 286-294. Urfa

[30] Erdoğan E. and Yazgan M., 2009. Landscaping in reducing traffic noise problem in cities: Ankara case. Afr. J. Agric. Res., 4 (10): 1015-1022.

[31] Nagendra, H. and Rocchini, D., 2008. High resolution satellite imagery for tropical biodiversity assessment: the devil is in the detail. Biodiversity and Conserva- tion 17, 3431–3442.

[32] Heynen, N., Perkins, HA. and Roy, P., 2006. The impact of political economy on race and ethnicity in producing environmental inequality in Milwaukee. Urban Affairs Review 42, 3–25.

[33] Fernandez-Juricic, E., 2000. Avifaunal use of wooded streets in an urban landscape. Conservation Biology 14, 513–521.

[34] Chow, WTL. and Roth, M., 2006. Temporal dynamics of the urban heat island of Singapore. International Journal of Climatology 26, 2243–2260.

[35] McPherson, EG., Nowak, D., Heisler, G., Grimmond, S., Souch, C., Grant, R. and Rowntree, R., 1997. Quantifying urban forest structure, function and value: the Chicago Urban Forest Climate Project. Urban Ecosystems 1, 49–61.

[36] Maco, SE. And McPherson, EG., 2003. A practical approach to assessing structure, function and value of street tree populations in small communities. Journal of Arboriculture 29, 84–97.

[37] Beckett, KP., Freer-Smith, P. and Taylor, G., 2000. Effective tree species for local air- quality management. Journal of Arboriculture 26, 12–19.

[38] Kragh J., 1981. Road traffic noise attenuation by belts of trees. J. Sound Vib.74(2):235-241.

[39] Reethof, G., 1973. Effect of plantings on radiation of highway noise. Air Pollut. Control Aso. 23 (3), 185–189.

[40] Cook, DI. and Haverbeke, DF., 1977. Suburbon noise control with planting and solid barrier combinations Research bulletin p. 100. Lincoln: EM.

[41] Reethof G. and Heisler GM., 1976. Trees and forest for noise abatement and visual screening. USDA Forest Service General Technical Report, NE-22, pp. 39–48.
[42] Urgenc S., 1998. Genel Plantasyon ve Agaçlandırma Teknigi (Arborikültür), Istanbul Üniversitesi Yayın no. 444, ISBN: 975-404-443-0, I.Ü. Basımevi, Istanbul.
[43] Kragh J., 1979. Pilot study on railway noise attenuation by belts of trees. J. Sound Vib. 66 (3): 407–415.
[44] Fang CF and Ling DL., 2003. Investigation of the noise reduction provided by tree belts. Landscape and Urban Planning 63:187–195.
[45] Fang CF. and Ling DL., 2005. Guidance for noise reduction provided by tree belts. Landscape and Urban Planning 71: 29–34.
[46] Ozer S. and Irmak M., 2008. Determination of roadside noise reduction effectiveness of Pinus sylvestris L. and Populus nigra L. in Erzurum, Turkey. Environ. Monit. Assess., 144:191-197.
[47] Dursun S. and Ozdemir C., 1999. Konya İl Merkezinde Gürültü Kirliliği Haritasının Hazırlanması, Selcuk Universty Research Fund BAP Project, 1999, Konya.
[48] Nas B., Berktay A., Ertuğrul T., Aygün A. and Isık M., 2004. Vısualızatıon of road traffıc noıse levels usıng gıs ın the cıty of Konya. 3 rd. GIS Days in Turkey. October 6-9 2004, İstanbul.
[49] Chepesiuk R., 2005. Decibel hell: the effects of living in a noisy world. Environ Health Perspect 2005;113(1):A35–41.
[50] Bluhm GL., Berglind N., Nordling E. and Rosenlund M., 2007. Road traffic noise and hypertension. Occup Environ Med 2007;64:122–6.