Noise pollution and map of Konya city in Turkey

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Abstract

Noise generally is described as unwanted sound group. It affects the human health physically and psychologically. In the last century, population movement to the greater cities, disorder planned city development and increase of the motor vehicle in the traffic have been produced noise pollution and other environmental problems. In some cases, noise pollution can be more important than the other environmental problems. The most important factor which affects the noise pollution is the mistakes taken place during the application of the city plans due to different political and social factors. In this investigation, effect of the application of city plan (use of ideal usage on the road and building areas, and ratio between buildings and green areas) on noise pollution was studied. Geographical Information Systems (GIS) plays an important role in the noise mapping. Noise pollution map of Konya city in Turkey using GIS has been presented with the 366 sampling point selected on main roads in the city centre. A marked effect of increasing building levels on indoor noise pollution has been also found near the main roads.

***Key Words*:** Noise pollution, dBA, noise pollution map, GIS, traffic, city plan, motor vehicle.

Introduction

Out of order settling in the most of the cities has been occurred wrong settling plan or spoiling settling up to day. In several cities there are 6 to 10 floors buildings with high traffic of the 8-10 m width roads (Thorsson *et al*., 2004). The Turkish Noise Control Regulation numbered with 1996/13 says that "Noise maps show noise levels about 300 m from noise source must be prepared by the municipalities.", "Municipalities must be taken to necessary to decrease the noise pollution shown in the settling plans" (Anonym., 1986). However, most of the municipalities in Turkey have not presented the noise pollution maps because of they have insufficient qualified personal or their knowledge is not sufficient to show noise levels on the map.

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Transportation traffics on the motorway cause important noise pollution problems for the city landscape (Piedada et al, 1999). City noise levels can be investigated in three different ways as traffic and transportation; industrial activities; sport, marketing and entertainment facilities. Noise levels and sources must be known before to dispute against to noise in the different cities. Different group of people may be affected differently from the noise levels between 30-60 dBA. The effect may increases by increasing noise levels. City noise plan maps were prepared in the developed countries with data collected by equipment settled to noise measuring station. For example, the noise levels showing maps were prepared for main roads, motorways and airports. These maps are very important to show effects of noise to the environment and to give information about the noise control. It is important to monitor noise effects of existing noise sources and to study the possible noise effects on the environment of new plans. These effect studies support the decision-making process. Based on these studies, the plan with the less environmental impact can be selected and measures can be devised by which the environmental impact is reduced. Kluijvera and Stoterb (de Kluijvera & Stoterb, 2003) have discussed standardisation of noise mapping and GIS for optimising quality and efficiency of noise effect studies.

Increasing noise of airport and motorway traffic in the city centres have become a part of modern life (Okuguchi *et al*., 2002; Passchier-Vermeer, 1996; Griefahn, 2002). First step to decrease noise pollution is preparation of noise pollution maps. It is possible to compare the highest noise levels and noise locations on the noise pollution maps. Necessity of these maps that to see noise levels which people have been affected. An ideal noise pollution maps can give basic information about city traffic plan, its development, investigation of noise removal research and noise polluted places that must be worked on. Furthermore, noise maps are the evaluation of experimental study on different noise sources (highway, airport, railway and industrial noise) and investigation of basic human problems (Stanef, *et al,* 2003; Leth, 2003).

Industrial noise sources and main roads must be separated from human living place during preparation of city settling plans (Romilly, 1999; Jans, 2000). Noise level increases by increasing density of traffic. However these changes depend on number of factors. For example, while measuring the noise, proportion of the horn sound, instant break, heavy vehicle is important in the traffic. Traffic composition, road slope, road width, road surface peculiarity and distance to intersections are other important factors in the traffic noise. Road surface peculiarity and road slope were the same for all noise measured street in this investigation. For that reason, road surface peculiarity and road slope were not taken into

account for noise level comparison. Only traffic density and road width were taken into consideration for the data comparison. The aim of this investigation were preparation of noise pollution map from the numerical data obtained the average values of noise level measurements in the Konya (Turkey) city centre during three years period and effecting factors to noise pollution formation.

Materials and Method

Mainly traffic based noise measurements were collected from 366 sampling point in the Konya (Turkey) city centre during May 1997-2000. Sampling points were main streets or roads connected directly to main streets. Detailed specification of the sampling points was given in the report of Dursun and Özdemir (Dursun & Özdemir, 1999; Dursun *et al*., 2002). Noise levels ware measured by Testo-815 noise level meter calibrated before every measurement period. All measurements were taken about 165 cm high form the ground level which is accepted as human ear level.

Measurements were performed on the most of the crossroads which were motor-vehicles were effective for noise pollution in Konya city centre. More than one sampling point were selected on some crossroads where the location or situation is important. The data from each sampling point were collected between 07:00-09:00 in the morning, 11:30-13:30 at lunch time, and 15:30:17:30 in the evening during weekdays also weekends. Minimum three measurements were performed for each day and time intervals, than average values were calculated. In this respect 27 data from each sampling point were collected and average values calculated. Numerical data were produced with average noise levels and x,y coordinates of sampling point. Konya city centre noise pollution map was prepared using locations and noise levels (Figure 1).

During preparation of noise pollution map, 1/50,000 scale map was produced by using numerical data merged 1/20,000 scale Konya city map. Konya city map in 1/20,000 scale was divided into the 9 equal parts which at least 4 known points (x, y coordinate) were taken in each of nine parts. Each one of nine parts was scanned at special scanner and images were saved into the personal computer. Acquired images were converted to numerical data form by the Bitmap Numerical Software (Wu, 2001). End of this operation, numerical data (x, y) of Konya city were obtained. Measured values of noise levels from each sampling point were entered as third dimension in numerical Konya city map. Afterward equal altitude lines were obtained from the numerical data by NetCAD software (Netcad for Windows, V 2.90) and

street and roads were located on the map. Kluijvera and Stoterb (2003) have discussed standardisation and presentation of noise map for the European Commission.

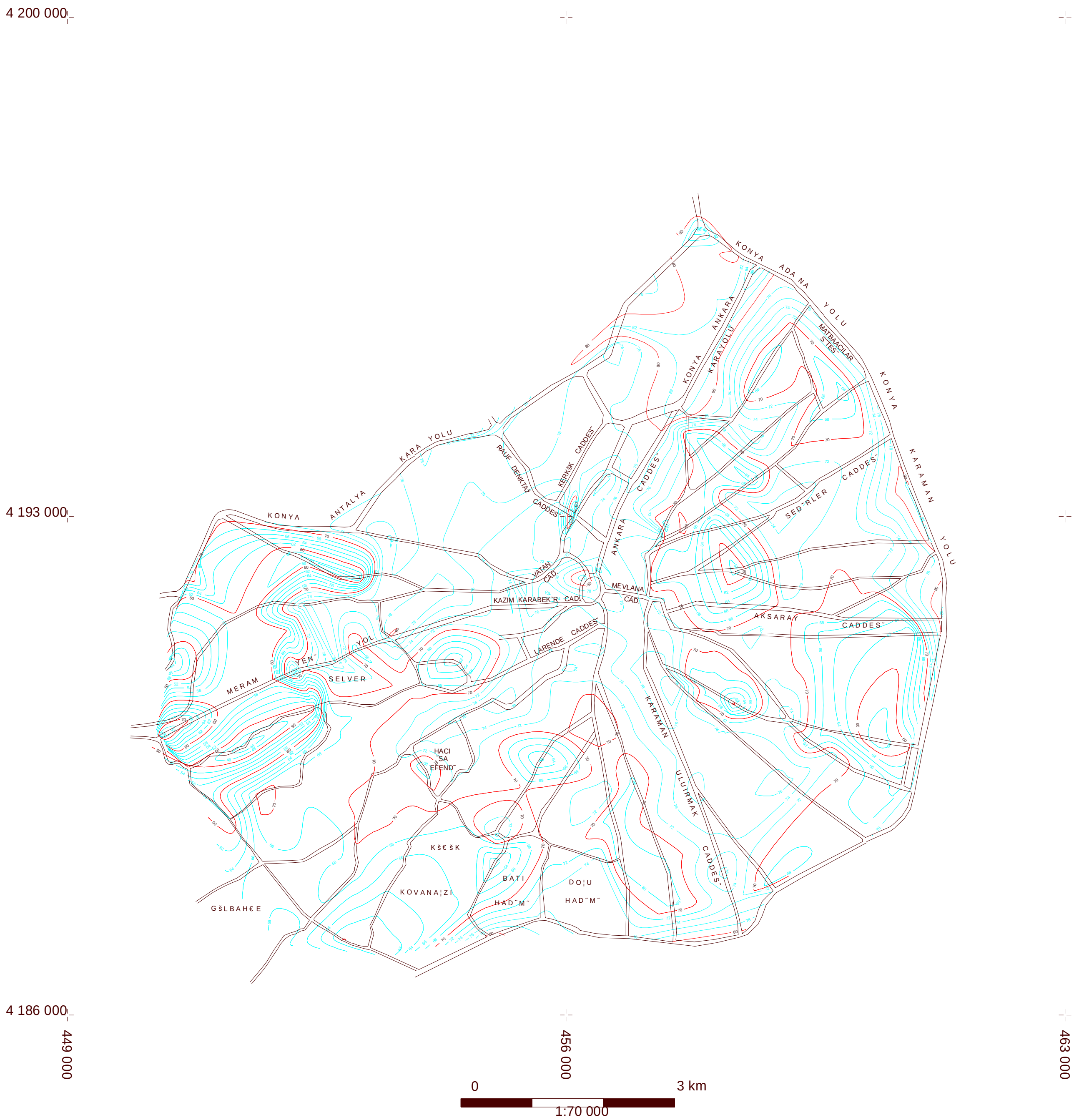

Figure 1. Noise pollution map of Konya City

Second part of this investigation, noise level variation at the building looking side to the Konya-Istanbul motorway were compared between building levels, distances to road, special isolated windows materials.

Results and Discussion

In this investigation, direct effect of architectural peculiarity on noise pollution was found and threshold level of 65 dBA was exceed all the region measured. Noise source factors were mainly transportation vehicle, architectural faults, usage of the nonisolated materials in the construction, vehicle horns and music, conditioning systems of some industrial work yards, machine stroke noise, on the other hand project or faulty material for road surface noise can also be included in noise source. Main noisy place in Konya city centre were Old Industry Region, Zafer Industry Region, around Central Coach Station, around Allaettin Hill, Sümerbank Cross, Istanbul Street and Sille Crossroad (Figure 1).

Noise levels of main roads near the unsettled region with high traffic density were not as high as settled region with narrow secondary streets. Because near the unsettled region, vehicle source noise can easily spread around, but not at street contain high density building near due to sound echo between the buildings, and there was sound room on these type of streets and sound waves cause echo's between opposite walls. There are noise control barriers both sides of the motorway in European countries. Construction characteristics of these barriers may sometimes decrease the noise level around the roads, but may increase on the road. Kyoji and Naotuki (1991) have compared the barrier construction materials for noise reduction in their study, absorptive cylinder materials has sound shielding efficiency.

Important factors affecting noise values are continuity of the city centre traffic, dimension of the roads, position of the roads and the road surface materials with city centre crossroad signal system (Berge, 1994; Tand & Tong, 2004). Disobeying traffic rules, irregular stop and move of vehicle especially minibuses (These minibuses are kind of buses for 14-15 people and very oftenly used for the public transportation in the city), wrong parking on the road, usage of the small motor vehicle to carry load in the Konya as known three wheel trasporter, appear as the noise causing problems for the traffic flow. The neglected secondary roads in the city centre are reason of noise pollution forming from the friction of wheel/road. Furthermore, the noise is increasing due to untrained drivers (much frequently breaking and horning habits). During the measurements, the noise level was increased to about 85 dBA by buses and minibuses for the public transport and when the heavy vehicles entered in the city centre illegally. These type of vehicles and three wheel transporters cause about 8 and 19 dBA increase in total noise level respectively. Main important factors of noise increase in the city centre were entering heavy vehicle illegally in city traffic to bring sugar beet, coal for fuel, raw products for Konya Sugar Industry Com. and to take away products of the factory like sugar, meals and waste of beet pieces.

Hamilton Ankesiyete test on 200 people (students and workers from different jobs) in Konya city centre showed that noise pollution is very important factor on people. As the result of the test, people were found effected about 38% continual, 23% frequently, 35% rarely by city noise and 4% of people were not affected in this investigation. Furthermore, this investigation on 200 people showed that air pollution is main environmental problem in Konya (24%) and other environmental problems are 23% water pollution, 21.5 noise pollution, 9% solid wastes, 8% creation area insufficiency and 3.5% untidy roads. About 11% of the participants of this test had no idea on environmental pollution.

Application of the sampling distance limits in the Turkish Noise Regulation is not possible to perform on main streets and artery roads in the Konya city centre (Anonym., 1986). The noise caused by the roads can reach to people about 20-25 m. When we go away about 300 m from the noise measurement point on one street, can reach to another street measurement. Mostly the noise levels of one street are effecting separate another street measurement. Perhaps it is not possible to find 600 m between two streets in national conditions, so that, the noise measurement may be possible in 300 m. For this reason, measurements were performed between to be mostly exposed people and source (street).

This investigation showed that there is a relationship between the noise level and traffic and also disordered city plan with the reference of measurements from 366 sampling point. Threshold level of 65 dBA was exceeding the most of measurement points. The results of measurements showed that taking measures are necessary to prevent noise pollution since all sampling point values are for sake of human health. It is necessary to make new arrangements with taking consideration the noise pollution on the main roads in and/or out of the city centre and if arrangement is not possible some noise decreasing percolation on these roads are required (Zeid, 2000).

Another point in this investigation is road width was affecting noise level increment. Two streets with different widthes but same vehicle numbers were compared, wide streets have less noise production with having large place of distribution, no horn nor high engine sound on unblocked road, but there was echo in large surface between the opposite buildings on the road. For example, the noise level was 73.1 dBA on the 20 m wide road with 4 vehicles in the traffic and noise level increased to 74.5 dBA by decreasing road width down to 10 m.

The vehicle type is another factor affecting the traffic source noise level too. Each vehicle produces noises in different levels and the vehicle type in the traffic is a valuable parameter for noise levels on the roads. There are different factors affecting on the noise levels in the streets, these are;

The vehicle horn sound was appeared most important factor affecting traffic noise levels. While noise level was between 65-75 dBA in the normal traffic affair on the street, noise level was suddenly increased over 83 dBA by single horn sound. In addition, instant stops, accelerating and music playing from vehicle in the traffic are effective in the noise level. Road work on or near by the road are also affecting noise levels too, but short term road works must not be taken into consideration in noise level evaluation. Traffic lights are decreasing noise level by decreasing vehicle speed and friction sound between road surface and wheels, other hand noise level is increasing by the heavy vehicles acceleration from the traffic lights.

An important noise pollution appeared with giving permission for urbanisation with high buildings (average 8 floors) very closed to road and heavy traffic, road including heavy vehicles near the Konya-Istanbul motorway. Urbanisation with high buildings of both sides of the motorway also which were constructed very close to road is an effective factor for high noise pollution. Increased noise levels were measured by going up in the buildings near the dense and heavy traffic without any sound isolation between the road and buildings. Noise pollution effect is less at lower floors of buildings than upper floors with the soil and surface plant cover near ground level, absorbing noise and noise effect was increased with increasing building levels (Zulfacar, 1974; Uluçaylı, 1987). Regression analysis between the building levels from the ground level to top level and noise measurements at these levels is given equation below. Usage of the isolation characteristic materials for window systems reduced noise level between 20-40%.

$$y=73+1.75x \qquad (r^2=0.96)$$

Croweded roads, loud music and street sellers in daily life were also affected human psychology in the cities (Thinness, 1978; Cabrera & Lee, 2000). People mostly sensitive to sound are starting to complaint after 35-40 dBA. These type of complaints increase more than day time at night. For this reason, non-echo and materials with isolation peculiarity must be used for construction of the residence buildings near the road and must be attached importance to the architectural acoustic of urbanisation (Jones & Galloway, 1971). Roads that are distant, but with dense traffic, can also be influential. Even though they are far from the receiver, a higher average speed and a larger vehicle flow can make the noise immission into the area larger than for smaller roads that are closer. For propagation over long distances weather effects are very important, which may further increase the importance of including distant, large roads (Thorsson *et al*., 2004).

Precaution against to noise pollution must be produce standards for usage of materials with isolation peculiarity in construction and use duple-glass windows (Kyoji & Naotuki,. 1991). Traffic noise levels increase with increasing density of traffic related with the traffic composition, road slope, road width, road surface structure distance to crossroad (Tadeu 1997; Williams & McCrae, 1995).

Usage of barriers between the sound sources and receiver environment are also reduce noise pollution. These barriers can be natural materials like as some sorts of plants or artificial materials. When we put 3 cm artificial barrier between source and receiver, found more than 3 dBA decrease of traffic noise. Effect of natural barriers on the noise reduction changes with distance to sound source, height and wideness of barrier plant (Saenz & Stephens, 1986; Swifta *et al*., 1999).

This investigation showed that road made from faulty materials, deformation of roads, unrelated speed on the road, ignorance of drivers on environmental protection, faulty urbanisation plan affect the noise pollution in city centres. In this research, Konya noise pollution map was prepared taking consideration of all knowledge given above.

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References

Thorsson, P.J., Ögren, M., Kropp, W. (2004) Noise levels on the shielded side in cities using a flat city model, *App. Acoust*. **65**, 313-323.

Anonymous, (1986) *1986/13 Numbered Noise Control Regulation*, Environment Ministry of Turkey, Ankara-Turkey.

Piedada, O.M., Bavyer, M.E., Clodovou, D. (1999) Planning the Acoustic Urban Environment; A GIS Centred Approach, Int. *Semp. on "ACM GIS 99*" Kansas,.

de Kluijvera, H., Stoterb, J., (2003) Noise mapping and GIS: optimising quality and efficiency of noise effect studies, *Comp. Environ. Urban Sys*. **27**, 85-102.

Okuguchi, T., Osanai, T., Fujiwara, N., Kato, T., Metoki, N., Konta Y., Okumura, K. (2002) Effect of losartan on nocturnal blood pressure in patients with stroke: comparison with angiogenesis converting enzyme inhibitor, *Am. J. Hypertension*, **15**, 998-1002.

Passchier-Vermeer W. (1996) Effects of Noise on Health, *Noise/News International, Report on Noise and Health*, pp. 137–150, Committee of the Health Council of The Netherlands.

Griefahn, B. (2002) Sleep disturbances related to environmental noise, *Noise Health* **4**, 57-60.

Stanef, D.A., Hansen C.H., Morgans, R.C., (2003)Active control analysis of mining vehicle cabin noise using finite element modelling, *J. Sound Vib.* **267**, 262-273,.

Leth, S. (2003) Train noise reduction scenarios for compliance with future noise legislation, *J Sound Vib*. **267**, 675–687,.

Romilly, P. (1999) Substitution of bus for car travel in urban Britain: an economic evaluation of bus and car exhaust emission and other costs, *Trans. Research Part D: Trans. Environ.* **4**, 109-125,.

Jans, F. (2000) Calculation Noise Barrier Performance in a Turbulence Atmosphere, *Acta, Acoustical*, **86**, 269-275.

Dursun, S., Özdemir, C. (1999) *Presentation of Noise Pollution Map in Konya City Centre*, Research Project, Selçuk University Research Project, Konya-Turkey,.

Dursun, Ş., Özdemir, C., Karabörk, H. Koçak. S. (2002) Noise Pollution Map of Konya City Centre and effect of Factors on Noise Pollution, *International Conference on the Environmental Problems of the Mediterranean Region,* 12-15.April.2002, pp:1497-1501, Near East University, Nicosia, North Cyprus..

Wu, M.C. (2001) Encoded Bitmap Indexes and Their Use for Data Warehouse Optimisation," *(*Shaker Verlag GmbH., Aachen.

Kyoji, F., Naotuki, F. (1991) Sound shielding efficiency of a barrier with a cylinder at the edge, *Noise Control Eng*. J. **37**, 5-11.

Berge, T. (1994) Vehicle Noise Emission Limits Influence on Traffic Noise Levels Past and Future, *Noise Control Eng. J*. **42**, 53-59.

Tang S. K. Tong, K. K. (2004) Estimating traffic noise for inclined roads with freely flowing traffic. *App. Acoust*. **65**, 171-181.

Zeid, N. Q. (2000) Measurement of Noise Pollution in the Community of Arraba," *Acta Acustica (Stuttgart),* **66**, 376-378.

Zulfacar, A. (1974) *Attenuation of Highway Generated Noise by Vegetative of Various Depths and Densities*, Ph. D. Thesis, Dept. of Environmental Health of the College of Medicine.

Uluçaylı, M. 1987) Noise Barriers, *Environment-87 Symposium*, Ed. F. Şengül, A. Müezzinoğlu, pp: 71-75 (26-28 Sep.1987), Dokuz Eylül University, İzmir-Turkey.

Thinness, G. (1978) Disturbance of Sleep by Noise*, J. Acoust. Soc. Am*." **64**, 216-222.

Cabrera I.N., Lee, M.H.M. (2000) Reducing Noise Pollution in the Hospital Setting by Establishing a Department of Sound: A Survey of Recent Research on the Effects of Noise and Music in Health Care, *Prevent. Med*. **30**, 339-345.

Jones, G., Galloway, W. (1971) *Motor Vehicle Noise: Identification and Analysis of Situations Contributing to Annoyance*, BBN Report 22082, USA.

Tadeu, A., Preira, A., Lima J., Mateus, D., (1997) Traffic Noise in the Arzila Wetland", *Tr. J. Eng. Environ. Sci*. **21**, 271-278.

[25]Williams I. D., McCrae, I. S. (1995) Road traffic nuisance in residential and commercial areas, *Sci. Total Environ*. **169**, 75-82.

Saenz A.L. & Stephens, R.W.B. (Eds.), (1986) Noise pollution, John Wiley and Sons, Chichester.

Swifta, M.J., Brisb, P., Horoshenkova, K.V. (1999) Acoustic absorption in re-cycled rubber granulate, *App. Acoust.* **57**, 203-212.