Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 9 (3): 479-487, 2009
ISSN 1812-5654

Presentation of Giresun City Traffic Noise Pollution Map Via Geographical Information System

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Abstract: Noise, which is a factor of sound pollution, is investigated in this study because it has negative effects on the people health. It is easily possible to plan the cities according to the necessity of the future, to investigate the sources of the noise, to determine the noise areas and to learn what precautions should be taken by means of the noise pollution maps. In this study done for this reason; the noise maps in Giresun city centre during mornings, afternoons and evenings are prepared by combining the measured noise values with the coordinates that are determined by Geographical Information System (GIS) receivers on the measurement points on Netcad 4.0 computer programme. Thanks to the noise pollution maps prepared, it is evidently carried out that the noise pollution level on the coastal motorway regarded as an international road is highly over the value which is declared in the instructions and it is almost at a level that threatens people' health. Reducing on the noise pollution level is remarkably seen because of decreasing of both the residential areas and commercial shops, getting away from the coastal line as going away from the city centre to the southern part of the city. Increasing on the noise pollution level is unfortunately observed in the regions since there are plenty of commercial shops, a lot of vehicles and people activities. Determining the present noise pollution situation in Giresun, the precautions to reduce the noise pollution are already found out. Putting in use of these determined precautions immediately will be extremely beneficial for keeping people's health living in Giresun city centre by reducing the noise pollution level.

Key words: GIS, NETCAD, city traffic, noise pollution map, Giresun

INTRODUCTION

Noise is one of the major environmental hazards of modern world originating from a wide variety of sources, including traffic (air, road, rail), industrial facilities, or social activities (Jakovljevic *et al*., 2006; Baubonyte and Grazulevicience, 2007). Transport noise is an increasingly prominent feature of the urban environment, making the noise pollution an important environmental public health issue (Clark *et al*., 2006; Baubonyte and Grazulevicience, 2007). The question Which noise sources have been disturbing you? was asked in a survey to the 860 participants in Brazil and it was concluded that 73% participants were irritated by noise pollution (Calixto *et al*., 2003). Noise pollution is the fifth one when ordered according to their importance and priority among the other environmental troubles which are experienced in Giresun region in the City Environment Problems and Their Priorities Inventory prepared by Environment and Forest Ministry in 2002 (Anonymous, 2002). It is primarily vital to pick up information about the degree and sources of noise for struggling against noise (Özdemir and Burdurlu, 1994). The first step of reducing noise is to prepare noise maps. Noise maps show the noise level and the position of the point having the highest noise level. On these maps, the basic is to be able to regard easily and simply the noise levels which people experience problems with. It is possible to get knowledge easily about city traffic plan, development, investigation of noise reduction work and determination of the areas with high noise where the noise reduction work will be done (Özdemir, 2005). Thanks to GIS technology, data bases can be built preparing scaled maps, the data classified can be simply questioned statistically. Nowadays, Geographical Information System has commonly been using through computers occupying our lives widely in planning of cities and regions, in preparing the noise and air pollution maps, in preparing and modelling the vegetation maps belong to natural reserve fields, in observing the usage of the water sources and in environmental effect evaluation studies. For instance; in

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the study done by Dursun and Özdemir (1999), by measuring noise pollution at 66 points in Konya city centre, it is pointed out that architectural features affected directly the noise emerged and 65 dBA level was spoilt in all areas. Scaled noise maps are prepared by transferring GIS noise measurement results. Akdağ (2003) made noise pollution measurement around Barbaros avenue in Beþiktaþ which is one of the centres in Istanbul, drawing attention to importance of noise pollution maps in city planning. He prepared maps manifesting noise pollution during day and night by transferring noise measurement results to GIS. Li *et al.* (2002) made an estimating illustration of road noise levels caused by traffic using Geographical Information System (GIS). Illustration was prepared regarding traffic situation, variety of vehicles, regional environment standards. Via prepared illustration by using GIS technology, noise level caused by traffic will be able to be estimated in cities in China. Zannin *et al.* (2002) examined the noise pollution by measuring equivalent noise levels (L_{eq}) at 1000 points where there were trade centres and industrial areas in the city centre in Curitaba, Brazil. Onuu (2000) determined the total values by measuring maximum traffic noise level (L_{max}) of the roads and equivalent noise level at over 60 points chosen in 8 cities in Nigeria.

The traffic flow was continuously increasing during the last decade; herewith traffic noise has increased approximately by 10-12 dB(A). An increase in community noise has a negative effect on the quality of life, because an increase in the noise level by 10 dB(A) is accepted by citizens as an increase in noise twice (Baubonyte and Grazulevicience, 2007). In the report published in 1996 by OECD on the being affected by noise, it is found out that noise starts disturbing at nearly 55-60 dBA, the disturbance goes up remarkably between 60-65 dBA and it causes significant health problems and behavioural disorders over 65 dBA (Anonymous, 1996; Akdağ, 2003). If we want to make a summary about the noise pollution spoiling people's health significantly under three subheadings explained below.

Physical effects: Lost in hearing, harm in hearing sense and organ, some illnesses based on extreme adrenaline growth.

Psychological effects: Disorders on the nerve system and behaviour, restlessness, spoilage of sleeping order, decreasing in mental process, disorders observed in concentration and motivation

Effects on social life: Declining in work performance and productivity. Beside these negative effects, that the noise causes people who has present tendency to become worse and worse their problems and diseases, makes treatment process longer, moreover, results in heart-vein disorders and behavioural changes is known (Liu and Tan, 2000).

Germany, France, Holland, England and Sweden can be mentioned among the countries where plenty of studies are done on noise maps. For example: In Germany, in 1960s, noise maps were started preparing based on measurement by considering only motorway traffic noise. In 1970's, estimating and illustrating methods of noise level began to be developed. Especially, after 1990, it is possible to prepare the maps fast, sensitive and detailed by means of computer programs. While noise maps of 40 cities and towns in Germany were made until 1940, this figure reached 350 in 1992 (Irmer, 2000; Akdağ, 2003). There are a great amount of similar studies in other countries.

via the help of noise maps:

- It would be provided the definition of noise problem at regional, general, national and international values and it will be easy to get information about manifesting the seize of being affected by noise, the width of the affected area, affected structures etc. On this subject, in a study covering European countries (Roovers *et al.*, 2000), it was stated that 32% of people were affected by 55 Leq (equivalent noise level) and 13% of those were affected by over 65 L_{eq}, totally 371.602.000, living mentioned countries, via the help of prepared noise maps in details. This shows that noise pollution is really an important problem in international platform
- It would be possible to have the costumers, institutions and foundations approach the trouble more seriously by determining the streets and regions influenced by noise seriously
- It would support to get information about arranging new regulations related to transport and determine the possible precautions -such as closing the road and banning traffic for long vehicles in certain hours- which can be taken for the regions affected transport and axle
- It would be possible to get detailed information on precautions to be taken in favour of structure or region if the level of noise is over according to instructions
- It would be the new information resources for present residents, new plans to be done and designing new town places
- It would provide data for doing additions corrections of current laws and instructions which were done before to struggle against noise pollution and be very useful (Roovers *et al.*, 2000; Akdağ, 2003)

In this study, because of benefits mentioned earlier, by using Netcad 4.0 GIS packet program, preparing the maps displaying the noise pollution in Giresun city centre during morning, noon and evening separately is aimed. The present noise pollution position in Giresun and precautions to be taken are determined.

MATERIALS AND METHODS

Giresun city located in the section of East Black Sea of Black Sea Region, is between 40° 07' to 41° 08' North latitudes and 37° 50' to 39° 12' East longitudes and with its area in 6,934 km^2, holds about 8.5% of country lands (Fig. 1) (Iltar, 2005). According to the population census in the year 2000, 83,636 people have been living in center district (Anonymous, 2004a).

In July and August in 2007, ninety nine measurement points on the main streets, intersections and connecting roads on which shops and traffic are dense are determined for mapping the noise level caused by traffic in Giresun. The coordinates of measurement points are clarified by a Magellan Sports Track handle type GIS. The data of determined coordinates are pointed on the city centre map which is Netcad format (prepared by Giresun Municipality) by using Netcad 4.0 GIS. The map prepared to show the noise measurement points is shown in Fig. 2.

In July and August in 2007, the measurements were done in the morning between 8.00-9.30, at noon between 12.00-13.30 and in the evening 17.00-20.00 when traffic is dense both on weekdays and at the weekends by Testo 815 device at 99 measurement points. In the end of the measurements done both on weekdays and at the weekends, noise level of the measurements points during morning, noon and evening are determined by finding total equivalent noise measurement level (L_{eq}). Because of width and situation of some streets and avenues, measurements were done more than one points. The measurements were done at 1.5 m height on the edges of the pavements on the road or intersection whose noise level would be measured. Koushki *et al.* (1999) and Baaj *et al.* (2001) measured at 1.5 m height, whereas, Onuu (2000) and Leong and Lartanakul (2003) measured at 1.2 m height. As for Dursun and Özdemir (1999) measured at 1.65-1.80 m height which was normal for ear level.

Noise values (L_{eq}) founded with the measurement and coordinates of the points are marked as equal-height curves by using Netcad 4.0 GIS packet program (Anonymous, 2005c) and maps are prepared showing noise pollution during morning, noon and evening hours in the city centre. Prepared maps are shown in Fig. 3-5. Additionally, maximum traffic noise level (L_{max}) of the roads in the city centre were measured and standard value was determined.

Fig. 1: The location of the city Giresun in the region (Anonymous, 2007)

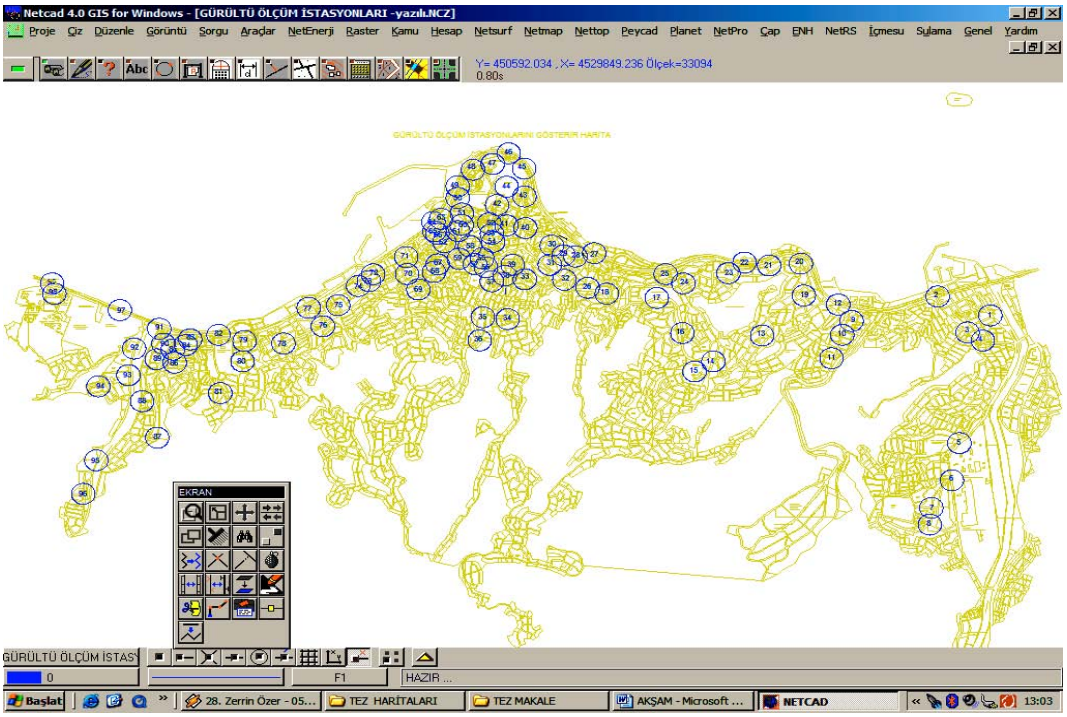

Fig. 2: Maps showing noise measurement points

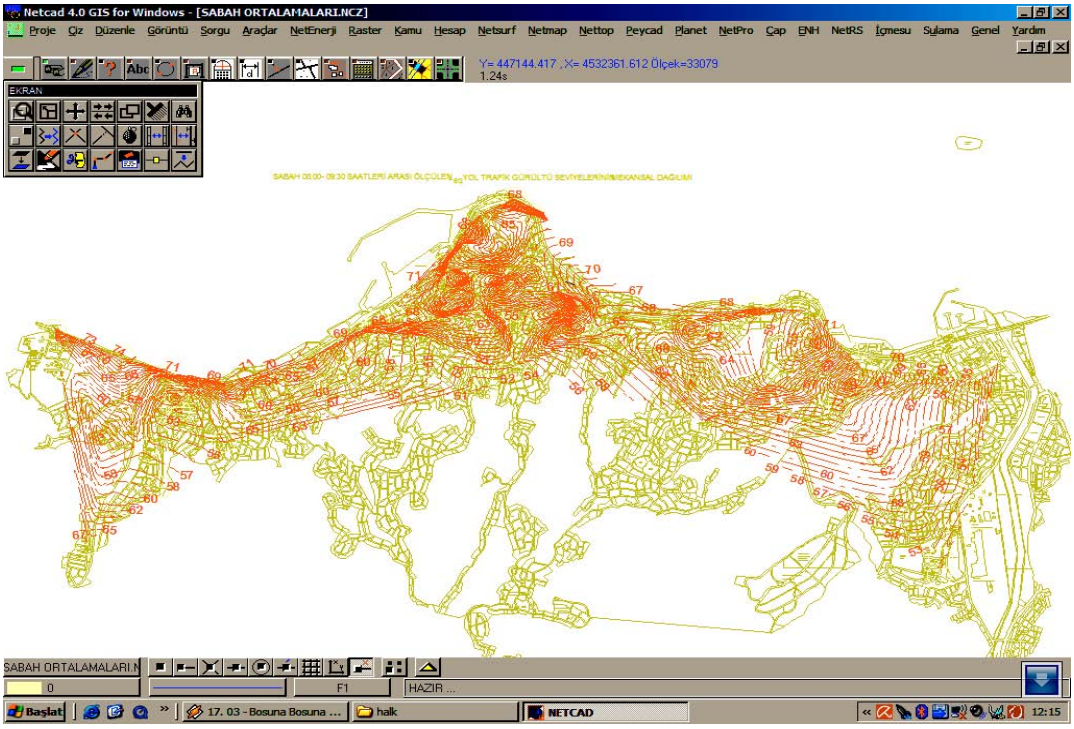

Fig. 3: Dispersion of road traffic noise level locally between 8.00 and 9.30 in the morning

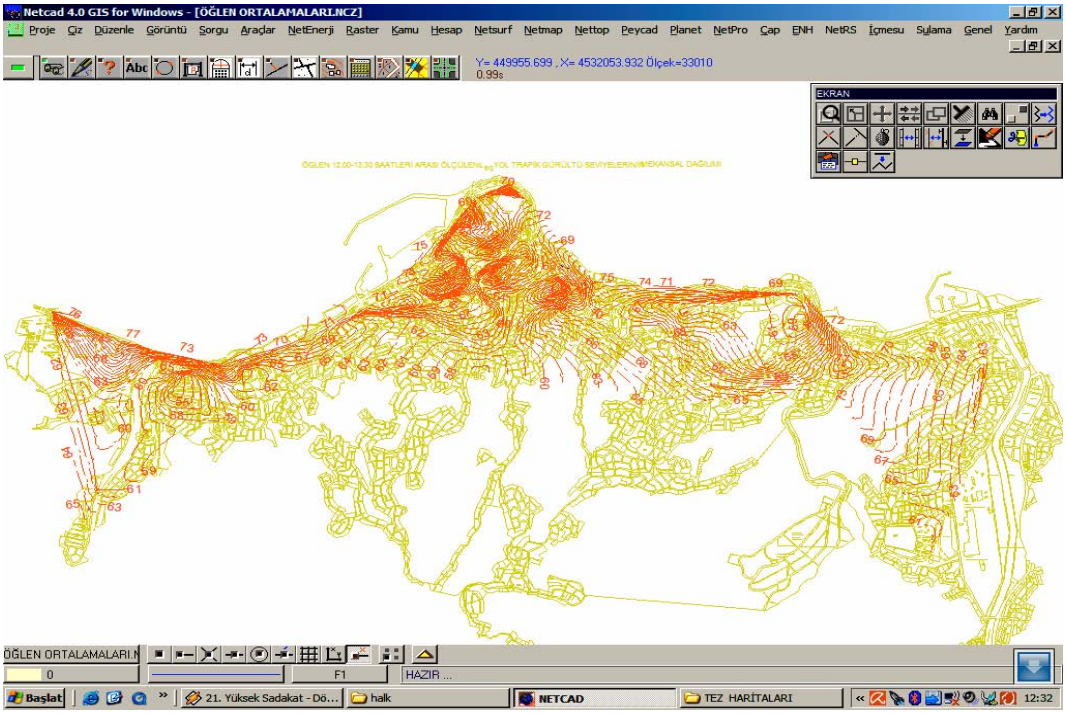

Fig. 4: Dispersion of road traffic noise level locally between12.00-13.30 at noon

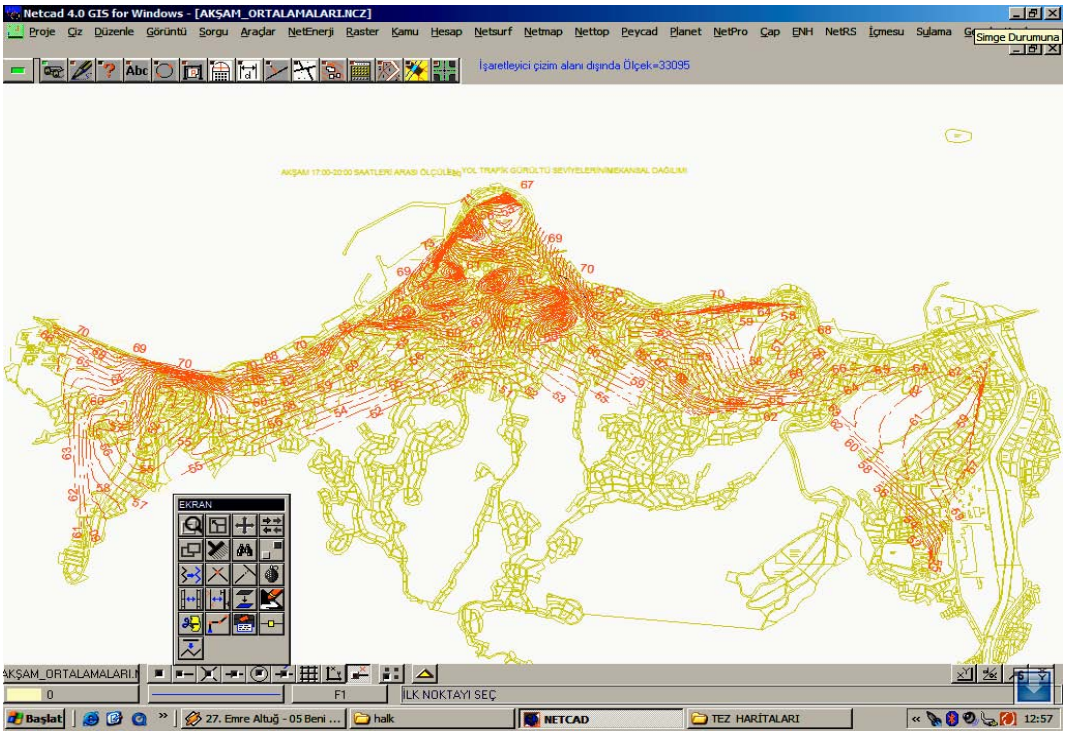

Fig. 5: Dispersion of road traffic noise level locally between 17.00-20.00 in the evening

RESULTS AND DISCUSSION

TurkWhen Annual Total Daily Traffic (ATDT) values in Giresun city centre was examined, in 2004, 13.957 cars, 1.215 medium loaded vehicles, 559 buses, 2.369 lorries, 414 trucks, totally 18.514 vehicles travelled through Giresun (Anonymous, 2004b). Total 19,070 vehicles passed through the city centre in 2005 (Anonymous, 2005a). When the vehicles in Giresun are examined according to their kinds, there are 13.148 cars, 177 buses, 5.333 minibuses, 3.583 lorries, 6.020 pick up trucks, 571 bikes, 1.979 tractors, 61 pullers, 90 private aimed vehicles, 63 tanks, 652 land vehicles, totally 31.677 motorized vehicles in Giresun (Anonymous, 2004a).

Occurring numbers at different decibel values during morning, noon and evening measurements of traffic equivalent noise level (L_{eq}) of the roads in the city centre are shown in Table 1. Occurring numbers at different decibel values during morning, noon and evening measurements of traffic maximum noise level (L_{max}) of the roads in the city centre are shown in Table 2.

The map showing 99 measurement points in the city centre is shown in Fig. 2. The noise pollution maps prepared in the end of the measurements done during morning, noon and evening are also shown in Fig. 3-5.

When the troubles which are experienced in Giresun region ordered according to their importance and priority in City Environment Problems and Their Priorities Inventory' prepared by Environment and Forest Ministry in 2002, the order is like that:

- Solid excrement
- Water pollution
- Coastal pollution
- Disorganized urbanization
- Noise pollution
- Visual pollution
- Erosion (Anonymous, 2002)

Table 1: Equivalent noise level values in Giresun city centre traffic

Measurement scale ($L_{eq\,(dBA)}$)	Measurement No.		
	Morning	Noon	Evening
$45<L_{eq}\leq 50$	3	2	3
$50<L_{eq}\leq 55$	24	3	18
$55<L_{eq}\leq 60$	25	18	30
$60<L_{eq}\leq 65$	20	37	22
$65<L_{eq}\leq 70$	14	12	13
$70<L_{eq}\leq 75$	11	17	10
$75<L_{eq}\leq 80$	1	10	3
$80<L_{eq}\leq 85$	1	0	0

Table 2: Maximum noise level values in Giresun city centre traffic

Measurement scale ($L_{max\,(dBA)}$)	Measurement No.
$45<L_{max}\leq 50$	---
$50<L_{max}\leq 55$	---
$55<L_{max}\leq 60$	---
$60<L_{max}\leq 65$	4
$65<L_{max}\leq 70$	4
$70<L_{max}\leq 75$	17
$75<L_{max}\leq 80$	23
$80<L_{max}\leq 85$	21
$85<L_{max}\leq 90$	11
$90<L_{max}\leq 95$	16
$95<L_{max}\leq 100$	3

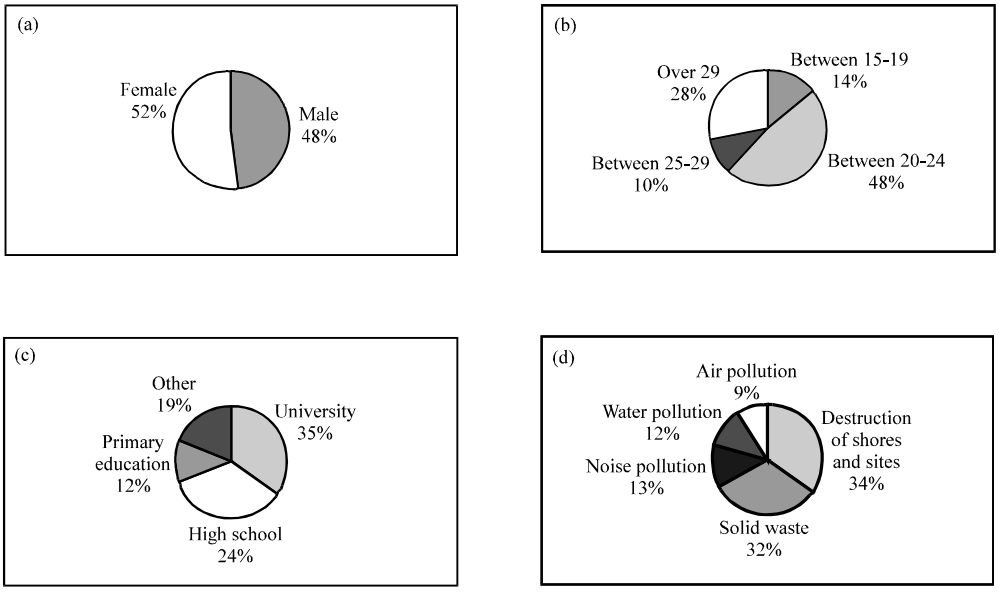

Fig. 6: Results of questionnaire (Anonymous, 2005b), (a) Gender of participants, (b) Age dispersion, (c) Educational statue and (d) The most significant environmental concerns in Giresun

In 2004, determining the most significant environmental problem and the precautions to be taken for this problem and the view of the people who live in the city were tried to carry out, via a questionnaire study was made by Giresun City environment and Forest Management and KTU, Giresun Teacher Training Faculty Environment Club (Anonymous, 2005b). In the survey which was done in the central Giresun, 140 individuals were interweaved and gender, age scale, education level and What are the three most important problems of Giresun? Can you tell putting in order? the answers for the questions given by these participants are summed up on Fig. 6a-d.

CONCLUSIONS

One of the most important factors which affects noise level caused traffic is number and kinds of the vehicles. Since each vehicle creates noise at different level, noise of vehicles becomes a factor that determines noise level. When Annual Total Daily Traffic (ATDT) values in Giresun city centre was examined, in 2004, totally 18.514 vehicles, in 2005 19.070 vehicles travelled through Giresun in the city centre, totally 31.677 motorized vehicles are present (Anonymous, 2004b, 2005a).

Occurring at different decibel values during morning, noon and evening measurements of traffic equivalent noise level (L_{eq}) of the roads in the city centre are shown in Table 1. According to this, it is observed that occurring rates of measurements between 60-65 dBA go up during morning, noon and evening hours. As understood from Table 1. The measurements occur between 45-85 dBA at 99 measurement points. The standard of the equivalent noise level at 99 measurement points is estimated as 60.66 in the morning, 64.65 at noon and 60.71 in the evening and standard L_{eq} is estimated 62.0.

Occurring at different decibel values of traffic maximum noise level (L_{max}) of the roads in the city centre are shown in Table 2. According to this, it is observed that occurring rates of measurements between 75-85 dBA go up and the measurements occur between 45-100 dBA at 99 measurement points. In the end of the measurements, the standard of the maximum noise level is estimated as 81.8.

Since Giresun is surrounded by Black Sea in the north and mountains in the south, land shortage is experienced and the city centre is compressed in a quite small area lying along the seaside. So, buildings are very close each other and plants which cause noise such as nut factories, cafes wedding ceremony halls, bakeries, small shops etc. are pressed in the city centre and increase the noise amount.

In many streets where noise pollution measurement done in the city centre, it is proved that noise pollution increases since the building are piled side by side in the streets. That the equivalent noise level (L_{eq}) which is 68 dBA is passed in Gazi, Cemal Gürsel and Fatih streets in which there are building established in that way is carried out.

The reasons creating noise sources in the city centre are primarily motorized vehicles, architectural mistakes caused by launching buildings in a wrong way, inadequate suitable isolation materials used in buildings, music market that make music all day placing loudspeakers on the roads and disorder ground structure of the roads. Klaxon noise coming from vehicles is another factor affects noise level caused by traffic. While noise level caused by traffic of the environment is 65 dBA during usual flow in traffic, it is determined that noise level suddenly increases to 74 dBA because of only one vehicles hooter voice.

Since Giresun harbour is in the city centre, while materials are unloaded from ship and while these materials such as coal, timbers and wheat etc. are carried by lorries, noise pollution level grows. While noise level caused by traffic of the environment is 68.5 dBA during usual flow in traffic, it is determined that noise level suddenly increases to 77.2 dBA because of the announcement done by municipality through loudspeakers.

While noise pollution is the fifth one when ordered according to their importance and priority among the other environmental troubles in the City Environment Problems and Their Priorities Inventory prepared by Environment and Forest Ministry in 2002, it is observed that this problem becomes 3rd in 2004. It shows that noise is getting more and more and becoming primarily environmental problem day by day when compared with the past. Furthermore, it shows the idea that people living in the region are aware that noise is another kind of pollution.

When a general evaluation of noise pollution maps is done, it is defined that noise level is over the value which is written in the instruction and becomes threatening for people's health on the coast road considered as an international motorway. Reducing on the noise pollution level is remarkably seen because of decreasing of both the residential areas and commercial shops, getting away from the coastal line as going away from the city centre to the southern part of the city. Increasing on the noise pollution level is seen in the regions since there are plenty of commercial shops, a lot of vehicles and people activities.

Especially, in Mustafa Kemal and Atatürk avenues being international roads, in Gazi, Cemal Gürsel, Fatih and

Alpaslan streets where there are many commercial shops, in Inönü, Orhan Yılmaz, Gedikkaya streets and in the big industry site, it is observed that noise level is quite high. Private aimed places and residential areas around the main streets in the city centre and the places in which there are plenty trade shops are influenced more by noise pollution.

When compared with these streets, in the streets having less noise pollution such as Pazar, Mehmet İzmen, Aksu, Nihatbey, Kavaklar, Yüzbaşısuyu, Sıraserviler, Yeşiltepe, Sinema, Sokakbaşı, Fevzipaşa, Osmanağa, Sazbeyi, Batlama streets, noise pollution has not reached at a disturbing level; however, if necessary precautions are not taken, in a short time, an extreme noise pollution level would appear in those places and in other places like those.

It would be highly useful immediately to apply the remedies stated below for inducing the noise pollution at minimum level and preventing noise concerns regarded as an significant trouble in Giresun.

An extreme disorder and unplanned urbanizing is dominant in Giresun. It is vital to prevent this disorganized urbanizing, to plan the industrial places on a separate area from the settlement places while they are built and to prohibit as possible as the buildings established side by side like detached houses. the buildings which are sensitive against noise such as schools, private education centres, hospitals, hotels, resorts are supposed to be built away from the city centre.

Giving more importance to isolation in these buildings to be built later, during the building process, it should be made to use materials providing noise isolation and made attractive. Moreover using double pane for windows in the buildings should be compulsory. Whether the materials are used or not for noise isolation in the buildings to prevent noise is to be checked seriously by municipality.

City centre can not provide benefit from the aspiration advantage of trees since there are almost no trees in the city centre. Additionally, no plantation work is done to decrease noise effects on the motorway sides and no recreation planning areas are built. Because of this, negative effect of noise should be induced by planting trees and plants around the city centre.

Shops such as bakeries, nut factories, cafes, restaurant, car cleaning places, fun places etc. causing noise are not allowed to be built under the flats or on the basement floor of the buildings. It should be provided to have necessary isolation in the present shops.

Since there is not adequate car parks in the city centre, people have to drive in the streets and avenues to park unnecessarily and this becomes an important factor rising the noise up. So, adequate car parks should be built in the city centre. Closed garage obligation on the base floor should be applied for the buildings to be built newly. the buildings not having closed garages are not allowed by Municipality Managements and Recreation and Residence Managements to utilize these buildings.

People causing noise pollution by using klaxon and explosive materials and escorting in long queues at weddings, soldiers sending, matches should be prevented by the police patrols in the city centre and it is not allowed to listen to loud music. The vehicles not having noise isolation and muffler system are quite often met in the city traffic. During the general controls, taxis and minibuses should be checked whether they have noise isolation and muffler system seriously and they should be prevented from using klaxon unnecessarily. Beside, during these checking, it should be provided that unnecessary devices such as klaxon which blows like whistling and loud volume must not be in the vehicles.

Since there are lots of holes on the roads and because of disorder way, vehicles make sudden brakes often so it causes an increase on the noise level. So, these roads should be made better by applying repairing work immediately in the city centre.

Placing loudspeakers out of the shops by music markets to sell cassettes and playing them all day increase noise level. Because of this, in shops like these, it should be banned to place loudspeakers out side and checking numbers should be risen up.

Moreover, by means of the loudspeaker placed by Municipality Management some announcements such as death, blood are done all day and these grow the noise amount in the city centre. It is very important to take away these devices from the city centre and to get in touch with local television and radio stations to make these announcements immediately. It is very vital to decline noise pollution.

By explaining the harmful effects of noise on people's health to the factory managers, self-employer who mostly cause noise pollution, employees, people, environmental training should be given and civil social institutions should be made active for this movement. An environmental training like that should be started at primary schools and it should be come to true by having people change their behaviour to live this change how long they live.

It should be provided to apply immediately and follow seriously of Evaluation of Environmental Noise and its Management Instruction' which was made basing on Environment Law with number 2872 and published and started currency in the Official Newspaper with number 25862 and date 01.07.2005.

It is necessary to plan the buildings according to future's requirements, to prepare 1/5,000 scaled Order Building Plans and 1/1,000 scaled Applying Building Plans, 1/25,000 scaled Environmental Order Plans immediately for preventing any kinds of environmental pollution and supporting usage and keeping balance throughout maintainable developing.

ACKNOWLEDGMENT

The authors are greatly indebted to the Scientific Research Projects Foundation of Selcuk University (Project No. 07101018) for giving financial support.

REFERENCES

Akdağ, N., 2003. Kent planlamada gürültü haritalarinin önemi: Barbaros bulvari çevresi örnegi, mimarlik dergisi, TMOB. Temmuz-Agustos Sayi., 312: 56-60.

Anonymous, 1996. Fighting noise. Paris, France, http://www.OECD.org.

Anonymous, 2002. T.C. Çevre ve Orman Bakanligi, Il Çevre Sorunlari ve Öncelikleri Envanteri. Ankara, http://www.cevreorman.gov.tr.

Anonymous, 2004a. Giresun Il Çevre ve Orman Müdürlügü, Giresun Il Çevre Durum Raporu. Giresun, pp: 184. http://www.cevreorman.gov.tr.

Anonymous, 2004b. T.C. Bayindirlik ve Iskân Bakanligi, Trabzon Karayollari 10. Bölge Müdürlügü Verileri, Ankara. http://www.bayindirlik.gov.tr.

Anonymous, 2005a. Netcad 4.0 GIS for windows. Netcad Yazilim Bilgisayar Ltd. Sti. 1996-2005, Ak Mühendislik Bilgisayar Ltd. Sti., Ankara.

Anonymous, 2005b. T.C. Bayindirlik ve Iskân Bakanligi, Trabzon Karayollari 10. Bölge Müdürlügü Verileri, Ankara. http://www.bayindirlik.gov.tr.

Anonymous, 2005c. T.C. Çevre ve Orman Bakanligi, Giresun Il Çevre ve Orman Müdürlügü Basin Bülteni, Giresun. http://www.cevreorman.gov.tr.

Anonymous, 2007. Turkey political map. http://www.aboutromania.com.

Baaj, M.H., M. El-Fadel, S.M. Shazbak and E. Saliby, 2001. Modelling noise at elevated highways in Urban Areas: A practical application. J. Urban Plann. Dev., 127: 169-180.

Baubonyte, I. and R. Grazuleviciene, 2007. Road traffic flow and environmental noise in Kaunas city. Environm. Res. Eng. Manage., 1: 49-54.

Calixto, A., F.B. Diniz and P.H.T. Zannin, 2003. The statistical modelling of road traffic noise in an urban setting. Cities, 20: 23-29.

Clark, Ch., R. Martin and T. Alfred, 2006. Exposure-effect relations between aircraft and road traffic noise exposure at school and reading comprehension. Am. J. Epidemiol., 163: 27-37.

Dursun, S. and C. Özdemir, 1999. Konya Il Merkezinde Gürültü Kirliligi Haritasinin Hazirlanmasi. Selçuk Ün. BAP. Proje No. 97-081, Konya.

Iltar, G., 2005. Giresun Ili Sahil Seridindeki Osmanli Mezar Taslari, Yüksek Lisans Tezi, Gazi Universitesi. Sayfa No. 7-10, Ankara.

Irmer, V.K.P., 2000. Assessment of conflict plans on the basis of noise mapping in Germany. August 27-30, Internoise 2000 Congress, Nice-France.

Jakovljevic, B., G. Belojevic, K. Paunovic and V. Stojanov, 2006. Road traffic noise and sleep disturbances in an urban population: Cross-sectional study. Croatian Med. J., 47: 125-133.

Koushki, P.A., O. Al-Saleh and S.Y. Ali, 1999. Traffic noise in Kuwait: Profiles and modelling residents perceptions. J. Urban Plann. Dev., 125: 101-109.

Leong, S.T. and P. Lartanakul, 2003. Monitoring and assessment of daily exposure of roadside workers to traffic noise levels in an Asian city: A case study of Bangkok streets. Environ. Monitor. Assess., 85: 69-85.

Li, B., S. Tao, R.W. Dawson, J. Cao and K. Lam, 2002. A GIS based road traffic noise prediction model. Applied Acoustics, 63: 679-691.

Liu, E.H.C. and S.M. Tan, 2000. Patients perception of sound levels in the surgical suite. J. Clin. Anesthesia, 12: 298-302.

Onuu, M.U., 2000. Road traffic noise in Nigeria: Measurements, analysis and evaluation of nuisance. J. Sound Vibration, 233: 391-405.

Özdemir, C. and Y. Burdurlu, 1994. Boyutlari ve Etkileri Açisindan Gürültü Kirliligi, Çevre Sempozyumu. S.Ü. Çevre Mühendisligi Bölümü. Konya.

Özdemir, C., 2005. Gürültü Kirliligi Ders Notlari, Selçuk Üniversitesi. Konya.

Roovers, C., G. Van Blokland and K. Psychas, 2000. Road traffic noise mapping on an European scale. Aug 27 to 30, Internoise 2000 Congress, Nice, France.

Zannin, P.H.T., F.B.R. Diniz and W.A. Barbosa, 2002. Environmental noise pollution in the city of curitiba, Brazil. Applied Acoustics, 63: 351-358.