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Noise Pollution Mapping in Konya (Turkey) City Hospitals Using GIS Model[#]

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Abstract: Noise is an important environmental problem today and can be defined as undesirable voices which affect people's auditory health and perception negatively, damage physical and psychological balance, bring negative effects on people. Noise pollution has become an important problem in metropolitan cities, because of the increasing population, industry and traffic load. Usage area of GIS has increased as a result of speedy development in information technology. Geografic Information System applications on health and environment gained currency in our country as well as in many country and have found application area in health centers, recently. Detecting noise level by preparing noise maps with using GIS has become very important fort in the hospital management and patients in taking measures for annoying voices to provide patients who come to hospital leave peacefully. In this study, noise maps of five different hospitals with excessive patients in Konya have been given with the help of GIS and recommendations were given in order to take measures fort the problematic places.

***Key words**: noise; environment; map; hospital; GIS; Konya*

Introduction

One of the important elements in the assessment and management of urban environmental noise is data collection in agglomerations. Various agencies and publications [1,2] specify that a noise map is a fundamental tool for the study, diagnosis and control of the environmental noise. In a study by Buelow[3] four Phoenix Emergency Department, including three large urban hospitals and a medium-sized suburban hospital, were monitored for sound level comparisons. The mean sound pressure levels of the three large urban hospitals were 69, 70, and 73 dB, and of the medium-sized suburban hospital was 67 dB. Zun and Downey[4] studied whether high noise levels affect the ability to hear heart and lung sounds. During their study they found minimum sound levels of 45 dB at the nursing station, trauma room, and private rooms. Mean sound pressure levels were 58, 56, and 46 dB, respectively, while maximum values for these three areas were 70, 81, and 62 dB, respectively.

Defined as undesirable, antipathetic, untenable voice, "noise" composes the fourth pollution area after air, water and soil pollution. Noise pollution which has arisen with the development in technology is one of the most important environment issues of today. However it is also one of the unknown environmental problems. Occasions such as the frequency of the noise, time span during which one is exposed to noise, physical distribution of this exposure, total duration of exposure to noise in working life in life time, age of the person, sensibility and his habitat, whether the noise is based on point, planar or linear source or not are important factors for the receiver to perceive noise as a disturbance. Noise threatens person's health both physiologically and psychologically [5] These threats are: Physical effects: negative effects on sense of hearing. These effects may cause temporary or permanent hearing loss.Physiological effects: possible results of these effects are increase in blood pressure, cogwheel rigidity, stress, irregular heartbeat, pupil enlargement, insomnia, and tachyon. Psychological effects: possible results of these effects are behavioural disorder, neurotic disorder, horror, discomfort, fatigue, deceleration in mental function. Effects on work success: decrease in working productivity and undesigning voices. It is proved that noise effects productivity and performance negatively. There is a meaningful relation between the noise level in workplace and productivity. The first time noise is regarded as a phenomena which threatens person's health and as

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an issue which government takes legal measures against is in England in 1960's [6]. Through the end of 1960's, similar practices became valid in USA as well. In Turkey noise is regarded as an issue which damages people's peace, physical and mental health in the context of environmental law in 1983.

The rate of voice intension of ten times higher of given intension equal to its logarithm according to ten bases is called Bel, one tenth of this is called decibel (dB). Noise level is given in decibel. Dose can be thought as the multiplication of noise level and duration. According to this, maximum daily dose is given in Table 1.

Table 1. Duration of voice intension which is on the edge of danger for ear [7].

Noise exposed period (hour/day)	Max. Noise Level (dB)
7.5	80
4	90
2	95
1	100
0.5	105
0.25	110
0.125	115

Noise level can be degree as such according to the negative results they make [8]:
Level 30–65 dB(B): Discomfort, disturbance, wrath, concentration and sleeping disorder,
Level 65-90 dB (B): Physiological reactions, increase in blood pressure, increase in heartbeat and respiration, decrease of pressure in brain fluid, reflexes,
Level 90-120 dB(B): Increase in physiological reactions, headaches,
Level > 120 dB(B): permanent damage in inner ear and imbalance,
Level > 140 dB(B): serious brain damage.

Presumed voice intension level in hospital accepted by Turkey Republic Prime Ministry, "Noise Control Regulation" is 35 dB. This level is between 20-30 dB in WHO publications [10]

Noise in hospitals is clearly a significant problem and little has been done to address it effectively. Acoustical consultants working on buildings are well aware of the value of developing a good relationship with their clients, research personnel is often less cognizant of the importance of collaboration with the end users of their work [12]. Noise levels are affecting patients staying period in hospital because of their complaining from high noise levels. Moreover some patients are leaving from the hospital before their treatment period after operation. Some of the unwanted noises are creaking doors, corrupted wheelchairs, air-condition systems, some medical instruments and phone rings. Food service some times produces disturbing noise level. Mobile phone usage was increased with industrialisation and communication between patients and their relatives also produce noise in and around services. In general from 1960's, hospital noise levels increased from 57 to 72 dB in day time, from 42 to 60 dB in night time. These figures for patients living room are higher than 35 dB accepted by WHO given in 1995 dated hospital noise guide. Noise levels are nearly similar at most of the hospital that show importance of noise pollution in hospitals [13].

Noise measurement 50 sampling places in a study at policlinic, clinic and other palces (radiology, laboratories, and corridore) of OMU hospital (Samsun-Turkey) showed that noise levels were 57.34±7.03 dB(A) at policlinics, 53.30±4.34 dB(A) at clinics and 61.17±5.04 dB(A) other places measured at time of 08:30, 09:00, 10:00, 13:30, 14:30 and 16:00 for 6 hours sampling period. Noise levels were the highest at 14:30 70 dB(A) policlinics, 13:30 and 14.30 62 dB(A) clinics and 10:00 71 dB(A) other places. Research showed that noise levels may be decreased using isolation materials and method in these places [14]. In another study [15] was performed similarly time period and noise levels was changed between 58,30 and 67,92 dB(A) at similar places. Maximum noise level was measured at sampling of main enternce (79,35 dbA) in this study. This study was sowed necessary of nosie pollution control in the many palces of hospital.

At the study of Tsiou at. al. [16] gives an evaluation of the problem of noise pollution in operating rooms. The high sound pressure level of noise in the operating theatre has a negative impact on communication between operating room personnel. The research took place at nine Greek public hospitals with more than 400 beds. The objective evaluation consisted of sound pressure level measurements in terms of L_{eq}, as well as peak sound pressure levels in recordings during 43 surgeries in order to identify sources of noise. The subjective evaluation consisted of a questionnaire answered by 684 operating room personnel. The maximum measured level of noise during the main procedure of an operation was measured at L_{eq}=71.9 dB(A), L_1=84.7 dB(A), L_{10}=76.2 dB(A), and L_{99}=56.7 dB(A). The hospital building, machinery, tools, and people in the operating room were the main noise factors. In order to eliminate excess noise in the operating room it may be necessary to adopt a multidisciplinary approach. An improvement in environment (background noise levels), the implementation of effective standards, and the focusing of the surgical team on noise matters are considered necessary changes.

Table 2 dB levels of some noise types and their effects [9]

Area of Usage	Voice pressure level (morning) (dBA)
Resting areas	
Theatre lounges	25
Conference lounges	30
Hotel bedrooms	30
Hotel restaurants	35
Health Institutions	
Hospitals	35
Residences	
Bedrooms	35
Living rooms	60
Service sections (kitchen, bathroom)	70
Educational Institutions	
Classrooms, laboratories	45
Fitness centre, dining halls	60

Table 3: Top noise levels of various usage areas[11].

Type of noise	dB Level	Psychological effects
Space Rockets	170	Ear ache, disorder in neurotic cells
Sirens	150	Ear ache, disorder in neurotic cells
Ear resistance level	140	Ear ache, disorder in neurotic cells
Machine drilling	120	Neurotic and psychological disorders (III.level)
Motorcycle	110	Neurotic and psychological disorders (III.level)
Cabaret song	100	Neurotic and psychological disorders (III.level)
Tube noise	90	Psychological symptoms (II. Level)
Dangerous zone	85	Psychological symptoms (II. Level)
Alarm clock	80	Psychological symptoms (II. Level)
Telephone bell	70	Psychological symptoms (II. Level)
Human voice	60	Psychological symptoms (II. Level)
Snore	30	Psychological symptoms (II. Level)

The study of Desider and Pragay [17] showed that the question of noise level in laboratories was considered and the results of noise level measurements made in various areas of chemistry, hematology and microbiology laboratories in 15 hospitals in the Western New York area were presented. It was concluded that even though the measured noise levels were within the limits set by OSHA, they were sometimes quite high and should be reduced whenever possible.

The aim of this sutudy was presentation of noise map of Konya city Hospitals and give information to decrease noise levels in and around hospitals. Noise map shows us the current noise condition and the points of the highest noise level. Noise map can be used as decision support system with the aim of decreasing the calculated voice levels in assigning the development of the city, planning city traffic. It is important for the hospital and vicinity to be quiet for patients in order to have a peaceful treatment, for this reason we aimed at measuring noise level of various points around a

hospital in working hours. As a result, it will be possible to take measures for the noisiest places by defining them.

In this research, noise levels in health institutions that are sensible to noise are detected, the way how the patients and employee working in these constructions are affected by the current noise is stated, and some recommendations are given. While deciding on the health institution that will be taken into the context of study, public hospital where patient immensity is high, private hospital where the immensity is lower, and university research hospital are chosen, noise measurements are taken in certain periods in the sections of policlinics, clinics, emergency, canteen, entrances. Comparing all the results, they are studied whether they correspond with the standards of WHO's presumed standards. To prevent artificial noise during measurement, momentary noise values (*i.e.* door slam, mobile phone *etc*.) are not recorded. In order to have a creditable research patients and employees are not informed during measurement (not to lose ordinary voice immensity) but later on.

MATERIAL METHOD

In the this study, indoors noise measurements are taken in five different hospitals in Konya including public hospitals, private and university hospitals. Noise measurements are daily; in the morning between 09.00-14.00 working hours, in the afternoon 13.00-14.00 visiting hours, in the evening 16.00-17.00 end of working peiods.

During measurements, a nose detection device of "Testo 815" model is used. Max. and min. noise measurements are taken in every corner of the hospital in every 10 secs. and the values are given dB by calculating the average of these values measured by the device.

GIS and Noise Pollution

In recent years, GIS (Geographic Information Systems) have become a vital tool fort he solution of problem fast and effectively. Usage of GIS in environment problems is one of the most successful and strong areas [18]. GIS, though used in areas such as city info system, agricultural practices, forestry practices, geological practices, defensive (martial) practices, vehicle tracking system and transportation, land usage and planning, land registering, water sources management (hydrology, water pollution), health and detective services, substructure management, education, state government, communication, archaeology effectively, it usage is limited in environmental practices [19, 20].

Making Konya Hospitals Noise Pollution Maps Presentation Using Gis

In this study, noise pollution maps of five different hospitals in Konya are made. Numerical map of Konya from Konya Municipality.Verbal data attained from hospitals (address, phone number, number of patients, number of doctors, average number of patients in a year). Noise detection device of "Testo 815" model.

Data processing and positional inquisitions, analysis

Digitized Konya map taken from Konya Municipality is brought to ArcviewGIS3.2 media in order to be converted into noise map. Pointing the places of hospitals on the map, attribution data and noise measurement values are integrated [21].

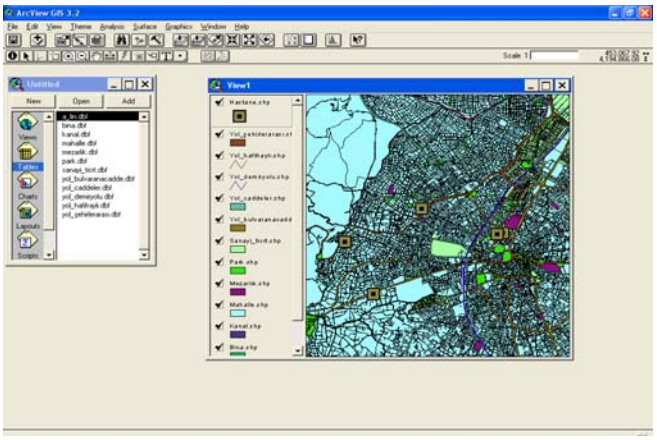

Figure 1. Positions of the measured maps on Konya map.

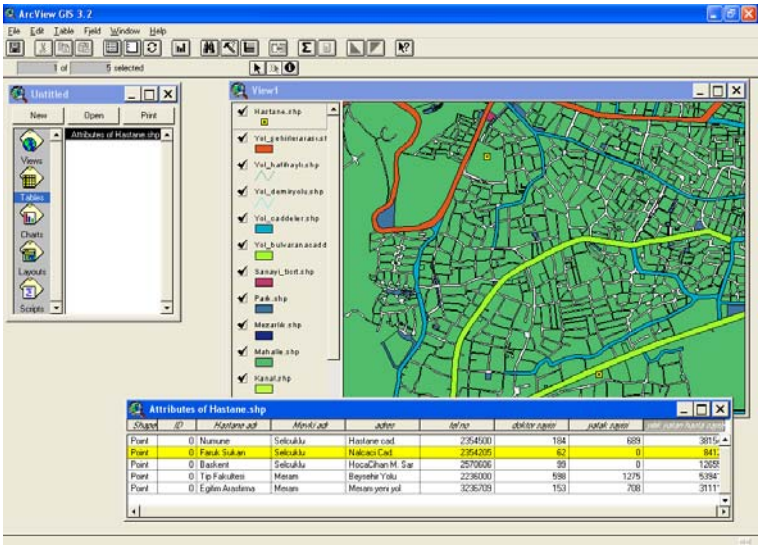

Figure 2. Acquisition of database of noise values

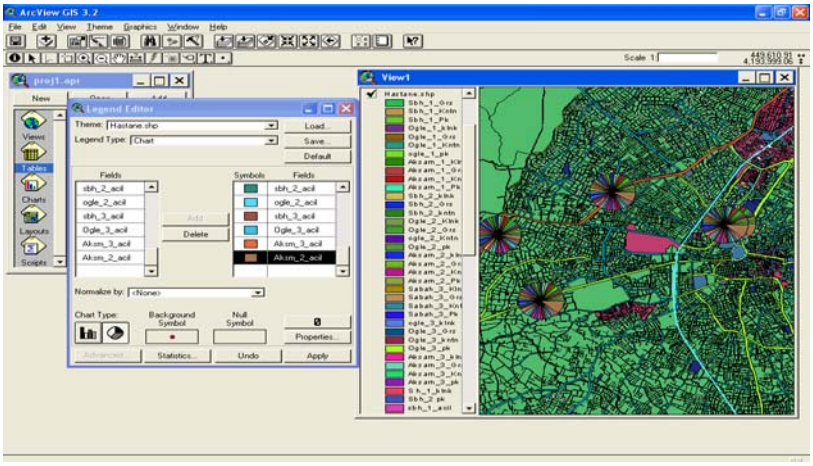

Figure 3. Various noise values in hospitals

Storing noise measurement values of 5 different health centres in GIS database, positional analysis are done. Taking noise values of morning, afternoon, evening periods in the policlinics of hospitals as base, analysis are done according to the noise levels in policlinics.

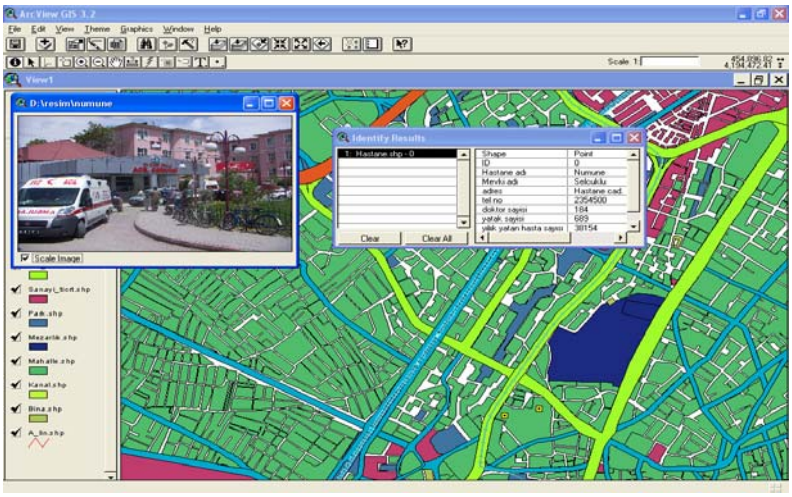

Figure 4. Positional information of the hospitals.

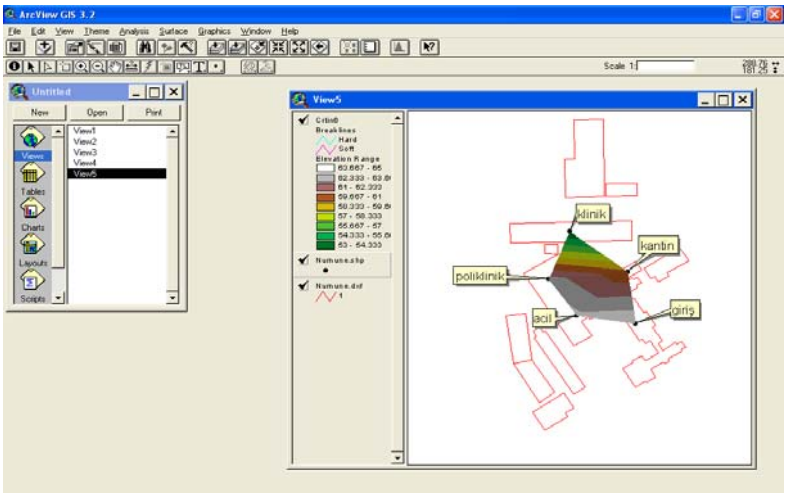

Figure 5. Sample Hospital. Analysis of noise values attained in the morning of the first day.

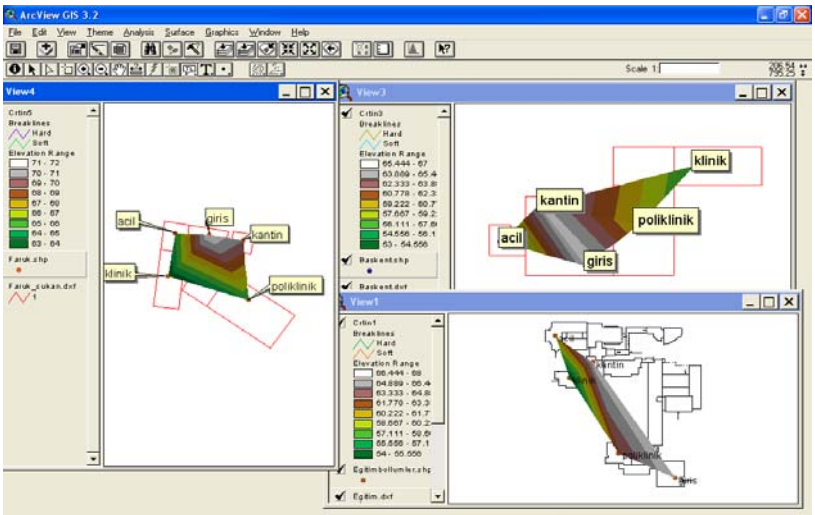

Figure 6. Baskent, education and research, Dr. Faruk Sukan Hospitals, comparison of noise values attained in the morning of the first day.

Results and Discussion

Noise has become an important element of environmental pollution as a result of increasing industry and urbanization. Although noise has many negative effect on people's health it is still not regarded as a risk in our society. However it is obvious that the best solution to protect ourselves from

the negative effects of noise is to monitor the source of this noise. This issue must be focused on in schools, workplaces and health institutions and social sensitivity must be raised.

In our regulation about noise there are various law and rules. Removing such diversities in the regulation, performing effective monitors and controls local managements' and employers' fulfilling their responsibilities about this issue would be effective in controlling noise pollution.

Noise pollution in hospitals has become an important problem all over the world. In the study presented, meaningful statistical data high above the presumed noise level of Noise Control Management is attained in all the hospitals measured. In addition to this, when compared these hospital among them, it is found that noise level in Baskent Hospital is far below the other four hospitals statistically. The reasons of this difference are that the average number of patients in the policlinic of Baskent Hospital is less, and the socio-economic levels of patients are higher.

Noise measurement values are higher in the morning rather than afternoon and evening because of the immensity of patients. And because of the visiting hours the values taken in the afternoon are higher than that of in the morning and evening.

In our study, it is observed that the most important noise sources are the patients and their relatives in the waiting rooms. In all the hospitals studied, all policlinic patients move in one and only place and altogether. Moreover, the voice intension of announcements being high and irregular contributes to the noise.

Noise values of hospitals are grouped as policlinics, clinics, emergency, canteen, entrance and the results of analysis are given by comparing values among themselves. Preventing noise pollution and controlling it effectively can be possible only by raising the awareness of society, clarifying legal responsibilities and judicial authorities.

Individuals' and society's converting their discomfort into conscious and coherent reaction could be possible with modern regulation and effective coherent application. Education of patient and employee is the most important aim of avoidable noise. With this aim both the patients and the employees must be educated with the help of oral and written warnings. Noise prevention crews should be organized in hospitals and indoor noise maps should be composed. In the context of these maps, activity areas sensible to noise and noise sources should be detected.

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