International Science and Technology Journal
المجلة الدولية للعلوم والتقنية

عدد خاص بالمؤتمر الليبي الدولي للعلوم التطبيقية و الهندسية دورته الثانية
LICASE -2
2024 / 10 / 30-29

المجلة الدولية للعلوم والتقنية
ISTJ

تم استلام الورقة بتاريخ:27/ 9/2024م وتم نشرها على الموقع بتاريخ: 30/ 10/2024م

An Assessment of Noise Pollution at the Major Hospital of Al Bayda City/Libya Using GIS and Remote Sensing Techniques

http://www.doi.org/10.62341/mtoa1649

Mohamed, T Bufarwa[1], Talal, A Mohamed[2], Omar, A Mohammed[3]

(1) Department of geographical Information system and remote sensing, faculty of natural resources and environment college, Omar AL Mokhtar University, Al Bayda, Libya. E-mail muhamed.tahr@omu.edu.ly
(2) Department of Environment, faculty of natural resources and environment college, Omar AL Mokhtar University, Al Bayda, Libya. E-mail Talalabudahaier@gmail.com
(3) Department of Wild life, faculty of natural resources and environment college, Omar AL Mokhtar University, Al Bayda, Libya. E-mail Omar.mohamed@omu.edu.ly

Abstract:
Noise refers to unwanted sound, which causes discomfort to the ears, and is measured in decibels dB. Very high levels of sound above 100 dB Could lead to permanent hearing loss. This study deals with the effect of noise in hospitals which are supposed to be the quietest. This study focuses on Al Bayda Main hospital, which is located in a very busy area of the city. Using high resolution satellite image, 70 noise stations were specified around the targeted therapeutics units and the hospitals border. Sound meter devices were used to measure the sound levels in these hotspots at two different times; from 17:00 to 18:00 Pm and from 24:00 to 01:00 Am. This noise level data converts to GIS program form mapping and allows the studying of spatial variation of noise intensity using "inverse distance weighting". Results illustrated that the Hospital street traffic noise integrated with the patients` visitors who stay in the green space in front the main entrance have significant impact on the therapeutics units reaching 75 dB in the day and 72 dB at night. Whilst the lowest noise ratio was in the area of the blood bank building which is located behind the main building, which is around 51 dB in the day and 49 dB at night. Authors were extremely surprised when measuring the Intensive Care Unit "ICU" at night to be 67 dB.
Key Words: Hospital Noise Pollution, GIS & Remote sensing, "Inverse Distance Weighting IDW, Noise Intensity AlBayda hospital /Libya

International Science and Technology Journal
المجلة الدولية للعلوم والتقنية

عدد خاص بالمؤتمر الليبي الدولي للعلوم التطبيقية و الهندسية دورته الثانية
LICASE -2
2024 / 10 / 30-29

المجلة الدولية للعلوم والتقنية
ISTJ

تم استلام الورقة بتاريخ:27/ 9/2024م وتم نشرها على الموقع بتاريخ: 30/ 10/2024م

تقييم التلوث الضوضائي في المستشفى الرئيسي بمدينة البيضاء – ليبيا باستخدام تقنيات نظم المعلومات الجغرافية والاستشعار عن بعد

بوفروة، محمد طاهر و [2] محمد، عمر إبراهيم و[3] بوظهير، طلال احمد.

[1] قسم نظم المعلومات المكانية والاستشعار عند بعد، كلية الموارد الطبيعية وعلوم البيئة، جامعة عمر المختار، البيضاء ليبيا. بريد الكتروني:
.muhamed.tahr@omu.edu.ly

[2] قسم البيئة، كلية الموارد الطبيعية وعلوم البيئة، جامعة عمر المختار/ البيضاء / ليبيا. بريد الكتروني
.Talalabudahaier@gmail.com

[3] قسم الحياة البرية، كلية الموارد الطبيعية وعلوم البيئة، جامعة عمر المختار/ البيضاء/ ليبيا. بريد الكتروني:
.Omar.mohamed@omu.edu.ly

الملخص:

المصطلح "الضوضاء" يشير إلى الأصوات غير المرغوب فيها التي تسبب إزعاجاً للأذن، ويُقاس مستوى الضوضاء بوحدة الديسيبل (dB). عند تجاوز مستوى الصوت 100dB، يمكن أن يؤدي ذلك إلى فقدان دائم للسمع. تستعرض هذه الدراسة تأثير الضوضاء في المستشفيات التي من المفترض أن تكون بيئات هادئة. تركزت الدراسة على مستشفى البيضاء الرئيسي الواقع في منطقة مزدحمة بمدينة البيضاء، ليبيا. باستخدام صور الأقمار الصناعية عالية الدقة، تم تحديد 70 نقطة قياس للضوضاء حول الوحدات العلاجية المستهدفة داخل المستشفى. تم قياس مستويات الصوت في هذه النقاط في فترتين زمنيتين؛ من الساعة 17:00 إلى 18:00 مساءً، ومن الساعة 24:00 إلى 01:00 صباحاً. تم إسقاط بيانات مستويات الضوضاء على مواقعها على الصور الفضائية باستخدام نظام المعلومات الجغرافية (GIS) لرسم خرائط تفصيلية لمنطقة الدراسة. وأظهرت الدراسة التباين المكاني لكثافة الضوضاء باستخدام أداة "مقلوب المسافة الوزنية ."كشفت النتائج أن ضجيج حركة المرور على شارع المستشفى، إلى جانب زوار المرضى المتواجدين باستمرار طوال اليوم والليل في الساحة الأمامية، له تأثير كبير على الوحدات العلاجية، حيث بلغ مستوى الضوضاء 75 dB نهاراً و72 dB ليلاً. في المقابل، كانت أقل مستويات الضوضاء في منطقة مبنى بنك الدم، حيث سجلت حوالي 51 dB نهاراً و49 dB ليلاً. وأثار دهشة الباحثين بشكل كبير وصول مستوى الضوضاء في وحدة العناية المركزة للرجال ليلاً إلى 67.dB

الكلمات المفتاحية:

التلوث الضوضائي في المستشفيات، نظم المعلومات الجغرافية والاستشعار عن بعد، طريقة ترجيح المسافة الوزنية شدة الضوضاء.

تم استلام الورقة بتاريخ:27/ 9/2024م وتم نشرها على الموقع بتاريخ: 30/ 10/2024م

1.0 Introduction:

Sound is a physical phenomenon that stimulates the sense of hearing [1]. Noise is defined as unwanted, unpleasant, or loud sound or sounds. It is commonly criticized as a pollution when it accedes the normal limits. Noise pollution refers to the excessive amount of disturbing sounds that can have negative effects on the environment and human physical and mental health. Although it is often overlooked, it is the third most dangerous factor for human health after air and water pollution [2] & [3]. The World Health Organisation (WHO) recognizes noise pollution as an increasing environmental problem that could result from various sources including traffic, industrial activities, airports, construction sites, recreational activities and even household appliances. Most developed countries around the world have noise pollution guidelines and regulations in place as well as specific times of the day to control and limit excessive noise. These regulations result in accepted levels of noise in various areas like commercial, industrial and even residential zones [4]. Hospitals are meant to be places for respite and healing where the least amount of noise is required, as it could cause significant effects on patients such as increasing levels of anxiety and inducing significant changes in the depth and quality of sleep and pain perception. This could also result in impaired staff concentration, productivity, and communication, leading to reduced performance in their tasks [5]. It appears that both day and night-time noise in hospitals has been increasing due to main factors of high level of background noise, high number of visitors, staff activity, and acoustic alarms of monitoring and therapeutic devices [6] .Sources of noise in a critical place like hospitals must be identified and mitigated. In order to take necessary measures at an individual, community, and government level such as promoting noise reduction technologies, implementing traffic regulations, noise barriers, and increasing the population`s awareness of the importance of reducing of noise pollution by educating population since early ages. Geographic Information System (GIS) and remote sensing technologies offer a comprehensive and spatial perspective that can play an essential role in identifying, visualizing, monitoring, and mitigating noise pollution in hospitals. It examines its impact on the surrounding areas to provide decision makers with information to create noise mitigation strategies and land development polices. In the current study, GIS and remote sensing techniques supported by field-collected data are applied to maps to visualise background noise in the therapeutic units of AlBayda General Hospital as well as the effects of noise levels coming from nearby main streets and shops.

2.0: Literature Review and Description

2.1: Understanding the Noise:

Noise is a form of energy, just like light and electricity. When an object vibrates, it also vibrates the air molecules in the air, and this vibrational energy lands on our human eardrums as a ‘sound’. These vibrations travel through the air in a series of waves known as sound waves. Sound has two important characteristics: loudness and frequency. Sound is measured by a universal unit called decibel (dB), which records sound pressure to be

classified into sound level scale. The logarithmic decibel scale goes up in powers of ten: each increase of 10 dB on the scale is equivalent to a 10-fold increase in sound intensity [7]. Noise is always defined as undesired and unpleasant sound, it becomes noise when the three elements (i) Sound Pattern, (ii) Sound Intensity and (iii) exposure duration are higher values than the specified norms. In other words, sound can be noisy for two reasons; Firstly, if it is too loud, then it becomes uncomfortable or even painful and dangerous. Generally, sound below 85 dB is considered to be safe. At around 110 dB, it becomes extremely loud, and at 140 dB, it reaches the threshold of pain. Second, loudness is not the only character to make the sound noisy, sound can be unpleasant because of how individuals perceive it. What is pleasant to some ears may be extremely annoying to others depending upon a number of psychological factors [8] (Figure-1).

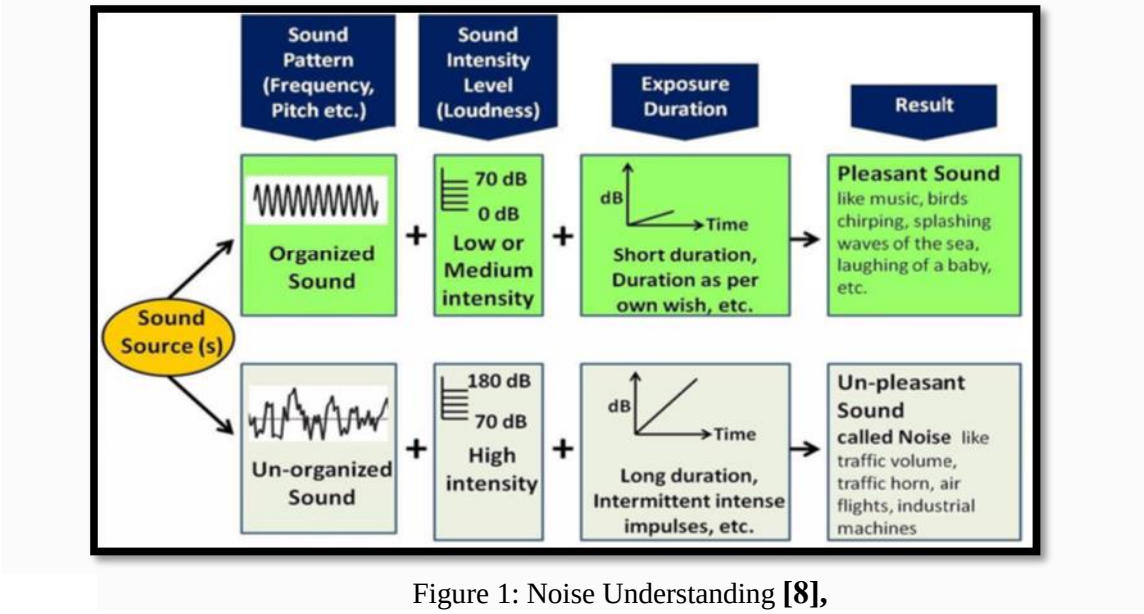

Figure 1: Noise Understanding **[8],**

2.2 Hospital Noise Levels:

In Hospitals Noise is an environmental stressor, affecting patients, their families, and hospital employees physiologically and psychologically. Patients report that the hospital is noisier than they are accustomed to, and that the sounds they do not understand add to their stress. Hospitals should be located in areas where patients can be treated in peace and quiet, where all of their physiological and psychological needs are met, and where they feel safer than at home [3]. According to The United States Environmental Protection Agency (USEPA) the recommended continuous background noise limit is 45 dB during the day and 35 dB at night in patient rooms. WHO also recommends a continuous background noise limit for hospital patient rooms of 35 dB, not to exceed 40 dB in wards. The guide line of the Chinese Medical Association was even more restricted as it recommends a noise limit of 35 dB during the daytime, 40 dB in the afternoon and

20 dB at night. Many surveys reveal that it is hard to reach these levels unless reducing the background noise levels by applying regulations to areas surrounding the medical institution, rather than inside it [9] & [10].

2.3 Literature review:

Excessive noise in hospitals disrupts patients' sleep and recovery, causes staff stress and fatigue, and impedes communication, that has been studied by many researchers in recent years. Some researchers investigated the sources of hospital noise. While others assessed the sound level of the technical equipment and its impact on the patients and material in the intensive care unit (ICU).

In 2013 Julie L and J Duncan Young monitored five ICUs in the UK to check compliance with the WHO guidelines which advices that average hospital sound levels should not exceed 35 dB with a maximum of 40 dB overnight. T wo recorded concurrently for 24 hours at the ICU central stations and adjacent to patients. Sample values to determine levels generated by equipment and external noise were also recorded in an empty ICU side room. The study results showed that the average sound levels steadily exceeded 45 dBA and for 50% of the time the noise ranged between 52 and 59 dBA in individual ICUs [11].. There was diurnal variation with values decreasing after evening handovers to an overnight average minimum of 51 dB at 4 AM. Peaks above 85 dB occurred at all sites, up to 16 times per hour overnight and more frequently during the day. Therefore, WHO sound levels guidelines could be only achieved in a side room by switching all equipment off [11].

Another study was applied in several hospitals in Taiwan to investigate the levels of noise pollution and to assess the physiological and psychological effects and annoyance response of medical care staff, patients, and visitors. The study method included using an instrument for the measurement of sound levels supported by self-answered survey questionnaire on noise pollution was administered. Results of the study revealed that the daily daytime average sound inside these hospitals was between 52.6 and 64.6 dB, which is higher than the environmental noise limit in hospital in Taiwan at 50 dB. According to the survey of the study the stuff members claimed that “talking of visitors or patient’s family members” is the major source of noise inside the wards, whereas “talking of visitors or patient’s family members” and “children playing” are the two major noise sources outside the wards. However, most patients or visitors claimed that “doors opening or closing” and “patients moaning or crying” are the two major sources of noise inside the wards [9].

In a study undertaken in 2009 in Taiwan, GIS and remote sensing techniques were applied to analyse the spatial distributions of the noise levels during each time interval were evaluated and visualized by geographic information systems. Noise data was

collected at varying intervals: morning, afternoon, and evening in 345 noise monitoring stations. The outcome analytical results of the study indicated that over 90% of the Tainan City population are exposed to unacceptable noise as defined by US Department of Housing and Urban Development. The highest average noise levels as 69.6 dB, while the lowest was 59.3 dB during mornings and winter evenings, respectively. According to the findings of the study, authors admitted that noise mapping is a powerful mean to investigate noise in various urban environments [12].

3.0 Materials And Methods:

3.1 Study Area:

The city of Al Bayda is located in the canter of the Al Jabal Al Akhdar region and is considered one of the most important cities in the region. It is bordered to the North by Al Osita, to the South is Wadi al-Kuf, to the East is the city of Shahat, and to the West is the city of Massah. It extends about 8 km in length and its width is on average 3.5 km long, and its area is estimated at about 29 km^2. Its general growth direction is from west to east, as it is almost integrated into an urban area of Shahat city. The population of the municipality of Al-Jabal Al-Akhdar is estimated to be about 550،000 people, according to estimates by the Department of Population statistics and census in 2020, and there is no doubt that the city has recently witnessed urban expansion resulting in a further increase. In terms of population and using the population growth equation, the current population of the city is estimated to be about 260،000 people. The city contains two main universities in the region and the master Hospital of the region, with various markets and shops, that made it an endeavor for the surrounding small cities and towns of the region **[13]** (Figure 2).

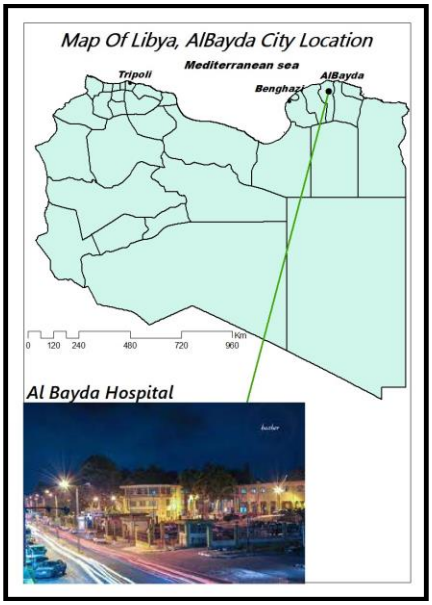

Figure 2: Location of AlBayda Hospital within the Map of Libya.

International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
عدد خاص بالمؤتمر الليبي الدولي للعلوم التطبيقية و الهندسية دورته الثانية
LICASE -2
2024 / 10 / 30-29
المجلة الدولية للعلوم والتقنية
ISTJ
تم استلام الورقة بتاريخ:27/ 9/2024م
وتم نشرها على الموقع بتاريخ: 30/ 10/2024م

3.2 Methodology:

Al Bayda main Hospital is located in the centre of the city, in the busiest commercial road where public gain their daily needs. Its bordered by four main roads, from the South there is the main street locally named after the hospital "Hospital Street" which is purely a commercial street, where there are tens of pharmacists, analysis laboratories, butcher shops, supermarkets, bakeries and clothing stores. From the East there is "Baghdad Street", a slope street full of butcher shops, laboratories, and Supermarkets. To the North of the Hospital, which is the back yard of the hospital, there is "Tarek Ben Ziad Street" which is a mixed residential street with less commercial activities. Finally from the West, the hospital bordered by "Therapy street" that is commercial street with various activities like Cafes, Laboratories and other shops (Figure 3). The medical visit at the hospital is held between 09:00 and 10:00 in the morning local time; patient visit is between 13:00 and 14:00; shift changes are made between 17:00 and 18:00; night medical visits are held between 21:00 and 22:00. However, that is not the case, due to the instability in the country, rules are not actually applied. Patient` visitors never leave the hospital, there is always a group of visitors in the hospital to be next to the patient, although it is strictly banned to be in the "ICU", they frequently try to enter to ensure that the patient is being treated well.

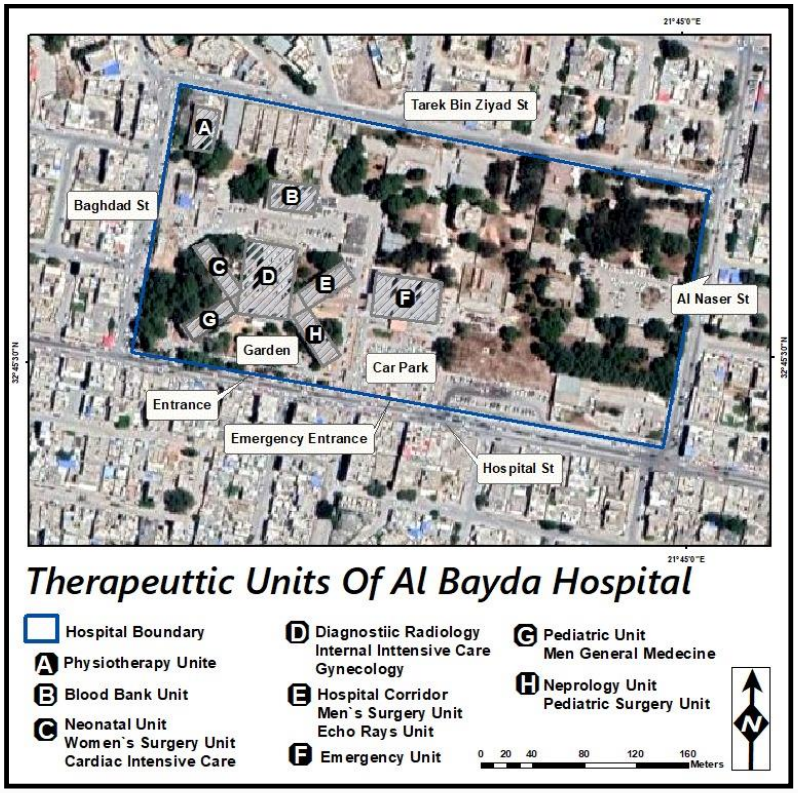

Figure 3: Therapeutic Units Of Al Bayda Hospital.

International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
عدد خاص بالمؤتمر الليبي الدولي للعلوم التطبيقية و الهندسية دورته الثانية
LICASE -2
2024 / 10 / 30-29
المجلة الدولية للعلوم والتقنية
ISTJ
تم استلام الورقة بتاريخ:27/ 9/2024م
وتم نشرها على الموقع بتاريخ: 30/ 10/2024م

Initially, in order to provide an overview the hospital`s layout including its premises and boundaries in addition to the surrounding architectural buildings, a high resolution satellite image was obtained from the Google earth platform covering an area of 26.27 Hectares (including 8.56 Hectares the border of Al Bayda Hospital). The Image was then georeferenced to assure that all the coordinates in the image are located in their actual place in GIS, this is applied by associating features on the google earth image with real world x and y coordinates. Arc/Map 10.8 was utilized to create a visual representation map illustrating relevant features, such as buildings, roads, and the hospital border, along with other relevant geographical information, The study is targeting the therapeutic buildings of the hospital therefore, these buildings were labelled on the map while the administrative sites of the hospital were not highlighted on the map (figure 3).
The second step of work is to identify the therapeutic units` potential noise sources. That was applied via designing a network of 70 noise control measures, 47 distributed around all the hospital therapeutic premises (with distances varying from 5 to 15 m), in addition to 23 stations by the hospital border to assess the impact of the external potential noise sources (Figure 4).

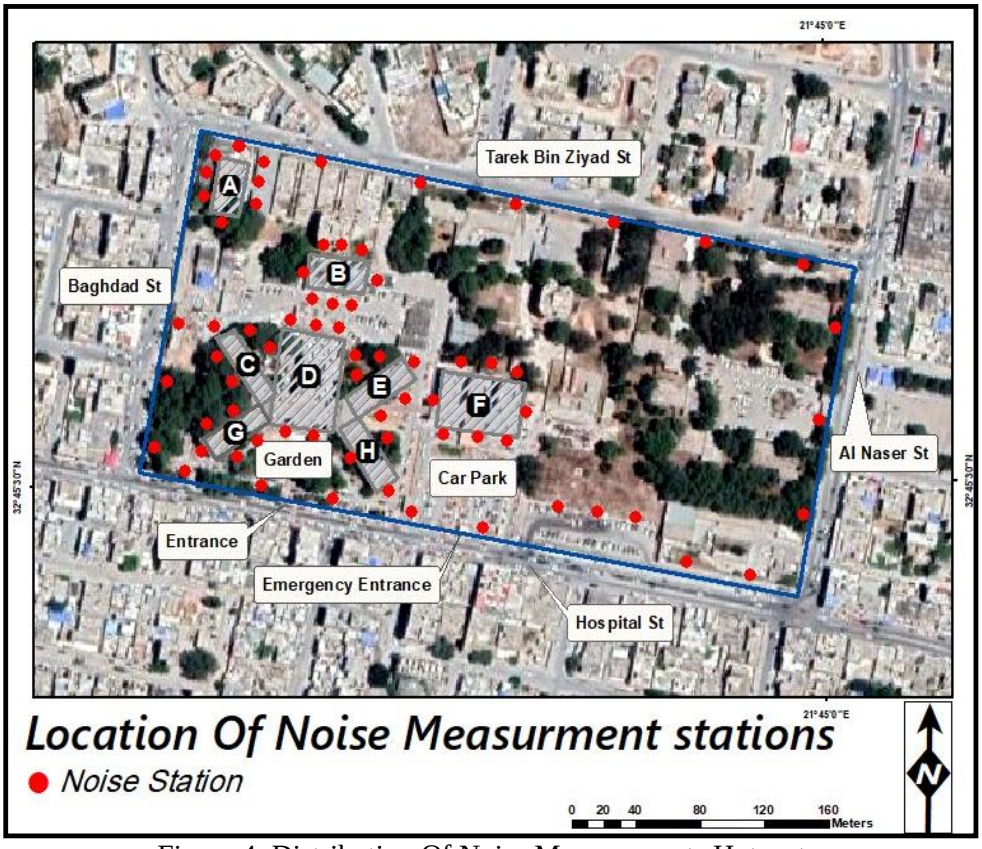

Figure 4: Distribution Of Noise Measurements Hotspots.

Digital sound level meter (Model-407732, Version 1.4) was used to measure the noise at each station point. The recording of noise levels for each point was for an average time of 6 minutes. Noise intensity measurements were taken during both night and daytime hours. Noise levels were measured from 17:00 to 18:00 pm, these hours are planned considering that the noise level at the specified hours is higher than other times as that's when most people go out to meet up and to buy their daily needs after nap time. Noise measurements were taken at night from 24:00 to 01:00 after midnight, when all patients need the lowest possible noise levels to be asleep.

The next step involved integrating the collected noise data with the hospital border map using Arc/Map software. By overlaying the noise data with the map, the noise levels are represented as red spots with attribute values corresponding to specific areas or sound sources. Hence noise pollution affecting both the hospital premises, and its surrounding area is then analyzed.

At this point, the noise extension and intensity have been measured using GIS interpolation tool named "Inverse Distance Weighting IDW" to create spatial map for both day and night- time data. Although Arc/Map offers several means to process the interpolation, the inverse distance weighting method shows the best results in the variation of intensity of noise. The IDW is a GIS interpolation technique that estimates cell values by averaging the values of sample data points in the neighborhood of each processing cell. The closer a point is to the centre of the cell being estimated, the more influence, or weight, it has in the averaging process
[14].

4.0 Results And Discussion:

The IDW supported by the field collected data has provided a visual representation of noise intensity in and around hospitals in both day (17:00 to 18:00 Pm) and night (24:00 to 01:00 Am) times. These times were intentionally meant to be selected for the aim of the study. 17:00 to 18:00 is supposed to be the busiest and noisiest time of the day in most cities and towns in Libya, as it's when local citizens complete their daily errands, do their shopping and social visits. Whilst at night, 24:00 to 01:00, is the time when the hospital noise should be at its lowest, and patients need to be a sleep. Therefore, the authors proposed these times as the most important for determining the noise level within this study. A total of 93 noise stations were utilized in order for the authors to obtain the most accurate results. Each noise spot needs almost 6 minutes to accurately measure noise, therefore this process has taken almost 25 days to record and prepare for the aim of the study.

In the day-time intensity map in (Figure 5), it shows a spatial distribution of the noise ranging from 51 to 75 dB at this time of the day. The front side of the Hospital by the hospital street, as well as Baghdad street side is significantly affected by the traffic noise reaching the highest noise levels of 71 to 75 dB. While the back side by Tarek Bin Ziad

street and Alnaser street it is less affected by the traffic noise at 66 to 71 dB in their highest noise exposure. The crossroads between Al Naser and hospital street has reached the noise threshold of 71 to 75 dB.

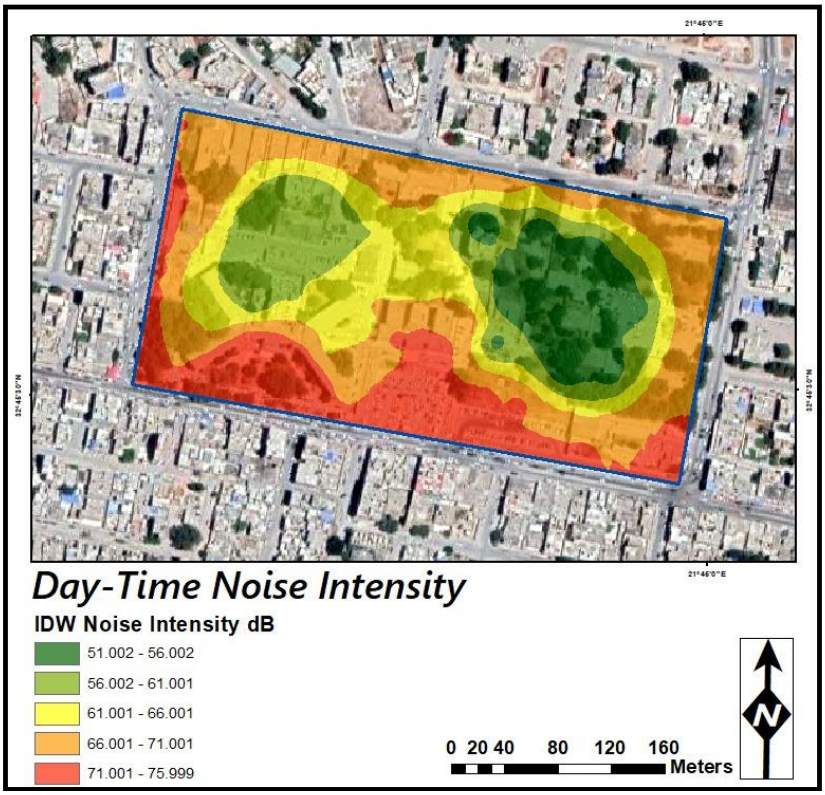

Figure 5: IDW Map Day-Time Noise Intensity.

The map highlights a heavy noise intensity of almost 75 dB in the green space at the front side of the diagnostic building, internal intensive care and Genecology building, as well as Neprology and paediatric surgery units, in addition to paediatric and men general unit. That seemed logical to the authors due to several reasons, most of the patients have their close relatives with them almost all day, and those relatives have their friends and families with them speaking loudly and using mobile phones at times increase the noise intensity in addition to the outside noise around the hospital. Making the garden almost full of groups of visitors. The visitors are most likely taking advantage of the moderate weather, since the study was applied in late August the weather was ranging from 20^{o} to 25^{o} at this time of the day, to sit in an open area and have coffee from the canteen in the hospital garden. Noise intensity is relatively lower in the area behind these Unit buildings ranging from 66 to 71 dB. The noise gradually decreases and reaches the lowest noise intensity of 56 to 51 dB around the blood bank at this time of day. The emergency unit building is receiving high levels of noise at approximately 71 dB, this is because the car park noise integrated with the traffics of the hospital street in addition to the alarms of emergency

تم استلام الورقة بتاريخ:27/ 9/2024م
وتم نشرها على الموقع بتاريخ: 30/ 10/2024م

cars and the emergency staff in the front of the emergency entrance. The Physiotherapy building is exposed to Tarek BinZiyad street traffic where noise is from moderate to high intense ranging from 66 to 71 dB (Figure 5).

The IDW map at night time (24:00 to 01:00 Am) in figure 6 illustrates lower spatial distribution than that of the day-time noise intense, which ranges from 49 dB at the lowest noise level to 72 dB at this time of the day at the hospital. The hospital street is significantly affecting the front side of the hospital with noise levels of 72 dB which is the highest noise intensity at this time of the day because of pharmacies and laboratories opening all night integrated with the traffic noise, although it not usually as crowded as during the day time, but most drivers drive relatively faster as the road is less crowded. Baghdad street has lower impact on the hospital west border at approximately 63 dB for the same reasons of the hospital street`s. Al Naser street has a moderate impact on the east fence of the hospital at around from 58 to 63 dB in some parts of the road. Tarek Bin Ziyad street has always been empty at this time of the night, apart from some cars after every few minutes making the back fence of the hospital the quietest side at 53 dB at this time

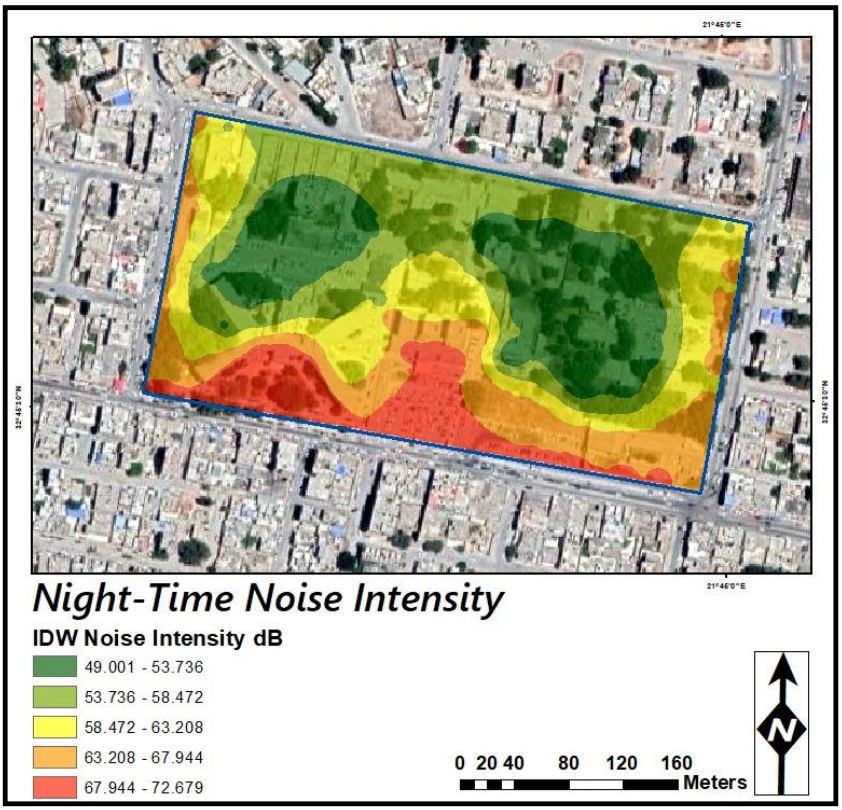

Figure 6: IDW Map Of Night-Time Noise Intensity.

For the same reasons mentioned earlier there is significant noise intensity at approximately 72 dB in the green space in the front side of the Diagnostic, internal intensive care and Genecology building, as well as Nephrology and paediatric surgery units, in addition to paediatric and men general units. The front side of emergency unit building observers high levels of noise at approximately 72 dB because of the car park noise along with the crowds of people in the main entrance of the unit supporting emergency staff, with emergency cars alarms. Noticeably, the back side of these buildings is much lower noise at 63 dB. Apparently, the noise intensity decrease towards the back side of the hospital where the buildings of men`s surgery, Eco rays, Neonatal, women`s surgery and the cardiac intensive units are which exposing as noise of 49 to 53 dB after midnight. According to authors, the source for this noise is from air condition systems with the conversations near the corridors` windows. Again, the blood bank unit is receiving the lowest noise level that is 49 dB.

Although it is strictly banned, for the sake of this project one of the authors had the chance to measure the noise level at the men`s intensive care unit at 01:00 am on the 2nd of September 2023, Surprisingly the average noise level inside was 67 dB. This is considered extremely noisy compared to WHO guidelines which suggest that average hospital sound levels should not exceed 35 dB with a maximum of 40 dB overnight.

5.0. Conclusion:

Results of this study determined that noise maps are an effective means of understanding noise level distributions in investigated areas. After taking field data at two times of the day and using 70 points distributed in the study area along with the statistical GIS analysis, the study constructed noise maps for Al Bayda main hospital to demonstrate the efficacy of noise mapping to investigate environmental noise. The spatial noise distribution maps using spatial interpolation “IDW” revealed that the hospital suffers serious noise pollution both during the day and even after midnight, which is extremely close to reality. Almost all the therapeutic units of the hospital are exposed to unacceptable noise environments, indicating that strategies for improving noise control are urgently needed. Most importantly the average noise level inside the “ICU” is almost twice as much as most of the universal agencies` standards. By using this evaluation mean, decision makers can easily identify the areas` most urgently requiring noise improvement as well as re-examine the adequacy of current regulatory standards.

The hospital buildings are well designed, however to reduce the surrounded noise intensity several developing strategies are needed to select the building elements in the design phase of such buildings. These are some recommendations to methods that could reduce noise:

- Renovate the exterior of buildings: use sound-insulating materials, sound-absorbing materials, and make the facade rough to weaken the reflected sound waves.

- Upgrade the damaged windows to a double-glazed to make them airtight.

- The use of curtains with a thick cloth enhances noise intensity reduction, and it is also possible to add somewhat thick floor coverings and cover the corridors with them to absorb the sound of those passing by in the corridor beside the therapeutics units.

Reference:

[1] Chauhan, B. S., Garg, N., Kumar, S., Gautam, C., & Purohit, G. (2023). Comparison of Analytical and Machine Learning Models in Traffic Noise Modeling and Predictions. MAPAN, 1-19.

[2] Jafari N, Bina B, Mortezaie S, Ebrahimi A, Abdolahnezhad A. Assessment of environmental noise pollution in Feiz hospital wards and its adjacent area. Health System Reaserch 2012; 8(3):377-84.

[3] Yarar, O., Temizsoy, E., & Günay, O. (2019). Noise pollution level in a pediatric hospital. International Journal of Environmental Science and Technology, 16, 5107-5112.

[4] Rahimi Moghadam, S., Laiegh Tizabi, M. N., Khanjani, N., Emkani, M., Taghavi Manesh, V., Mohammadi, A. A., ... & Najafi, H. (2018). Noise pollution and sleep disturbance among Neyshabur Hospital staff, Iran (2015). Journal of Occupational Health and Epidemiology, 7(1), 53-64.

[5] Hsu, T., Ryherd, E., Waye, K. P., & Ackerman, J. (2012). Noise pollution in hospitals: impact on patients. JCOM, 19(7), 301-9.

[6] Salandin, A., Arnold, J., & Kornadt, O. (2011). Noise in an intensive care unit. The Journal of the Acoustical Society of America, 130(6), 3754-3760.

[7] Abdulkareem, H. (2018). Evaluation of noise pollution indicators in Najaf city. Kufa Journal of Engineering, 9(4), 258-272.

[8] Bala, M., & Verma, D. (2020). Investigation & Examination of Noise Pollution-Definition, Sources, Effects, Monitoring and Control. Madhu Bala and Deepak Verma (2020),"Investigation & Examination of Noise Pollution-Definition, Sources, Effects, Monitoring and Control", International Journal of Research in Social Sciences, 10(7), 182-207.

[9] Juang, D. F., Lee, C. H., Yang, T., & Chang, M. C. (2010). Noise pollution and its effects on medical care workers and patients in hospitals. International Journal of Environmental Science & Technology, 7, 705-716.

[10] Cabrera, I. N., & Lee, M. H. (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. Preventive medicine, 30(4), 339-345.

[11] Darbyshire, J. L., & Young, J. D. (2013). An investigation of sound levels on intensive care units with reference to the WHO guidelines. Critical Care, 17, 1-8. Tsai, K. T., Lin, M. D., & Chen, Y. H. (2009). Noise mapping in urban environments: A Taiwan study. Applied Acoustics, 70(7), 964-972.

[12] Tsai, K. T., Lin, M. D., & Chen, Y. H. (2009). Noise mapping in urban environments: A Taiwan study. Applied Acoustics, 70(7), 964-972.

[13] At-twati, M Alsiddiq & Alzardoumi, R Ali. (2023). The spatial attraction of random solid waste dumps and their relationship to land use in the city of Al-Bayda. Global Libyan Journal, 68.

[14] Harman, B. I., Koseoglu, H., & Yigit, C. O. (2016). Performance evaluation of IDW, Kriging and multiquadric interpolation methods in producing noise mapping: A case study at the city of Isparta, Turkey. Applied Acoustics, 112, 147-157.

[15] Darbyshire, J. L., Müller-Trapet, M., Cheer, J., Fazi, F. M., & Young, J. D. (2019). Mapping sources of noise in an intensive care unit. Anaesthesia, 74(8), 1018-1025.