Noise level Evaluation and Control, social affectation and pollution mitigation plan carried out at the main higher education institutions in Riobamba

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Abstract

This work deals with the analysis, monitoring and evaluation of environmental noise around the Escuela Superior Politécnica de Chimborazo and Universidad Nacional de Chimborazo, these two emblematic higher education institutions are in the center of the country, where high levels of pollution have occurred. Acoustic noise is produced mainly by the rise of motorized equipment in the avenues. Through this investigative work, it is proposed to develop a mitigation plan against noise pollution which is very common in medium and large cities.

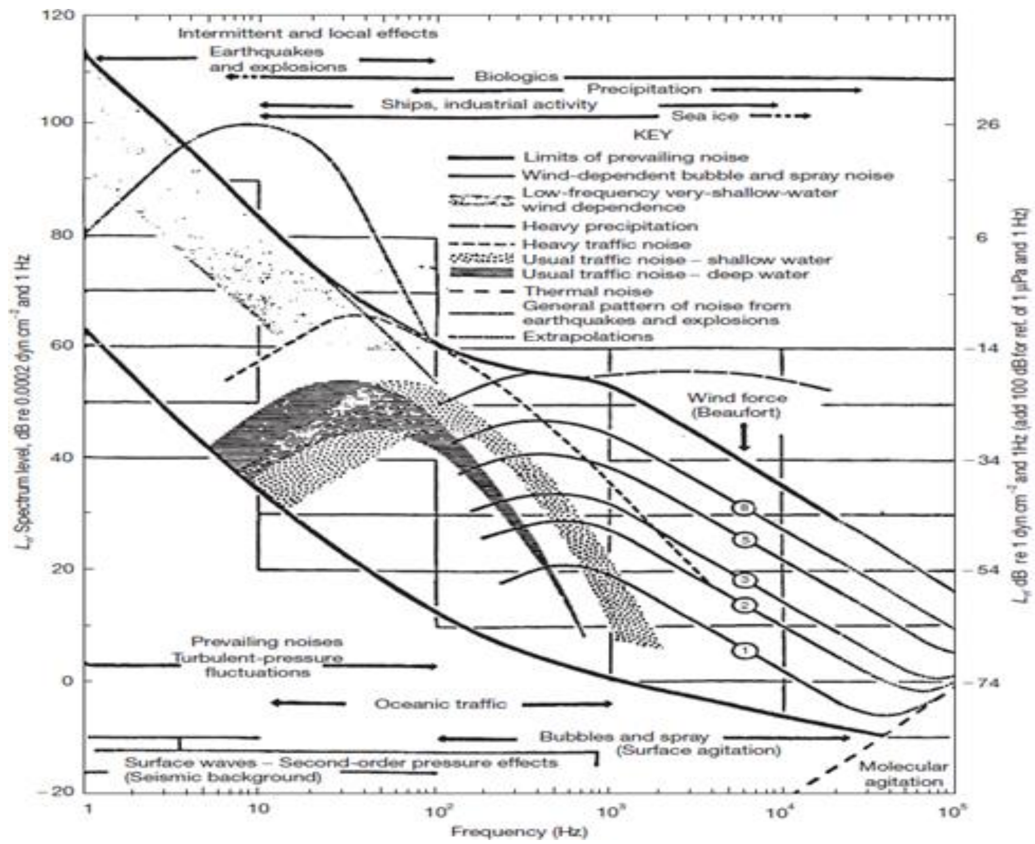
To carry out this research, the recognition of the two institutions is crucial, considering the schedules and activities that are carried out in them, their infrastructure distribution and facilities to de-termine the type of sampling. The mesh method was selected to obtain sufficient data for the study. With the preparation of planimetries of the places, the points to be monitored and georeferenced will be located, obtaining coordinates of each critical point. A professional Type 1 Sound Level Meter and Dosimeter will be used to monitor these points. These data was recorded during the morning, afternoon, and evening, with the staff support of the GISAI research group.

Keywords: *Covid -19, Georeferencing, Maps, Pollution, Statistics, University*.

1. Introduction

Sound occurs when there is a movement or pressure variations in a fluid medium and is generally all around us, whether it comes from a speaker or the rustlings of leaves due to wind or a car driving by. However, excessive sound may be annoying or objectionable to humans. The unwanted and / or excessive part of sound is termed ‘noise’, which has a fundamental distinction from the word ‘sound’. Noise pollution has become a serious issue in the current world, and therefore many researchers around the globe are actively performing research to find ways of reducing the noise to an acceptable level[1]. Noise pollution, a by-product of urbanization and industriali-zation, is now worldwide recognized as a major problem for the quality of life in urban areas. The increase in the population and in the number of circulating vehicles has led to an increase in noise pollution [2]. The World Health Organization (WHO) recog-nized noise as one of the major pollutants affecting the health of the human popula-tion[3]. it is caused by the urban population growth[4]. Dense transportation systems, including roads, railways, and air traffic, characterized by the modern urban envi-ronment. These systems have caused environmental noise also known as community noise pollution. In recent years, road traffic has played a dominant role in causing en-vironmental noise, which can have ill effects on communities[5, 6]. Recent evidence suggests that traffic noise may negatively impact mental health. However, existing systematic reviews provide an incomplete overview of the effects of all traffic noise sources on mental health[7]. Many researchers have reported that exposure to noise pollution increases the risks related to personal health, like irritability, muscle cramps, stress and anxiety, exhaustion, depression, headache and migraine, loss of body bal-ance, pain, hypertension, cardiovascular problems, gastrointestinal disturbances, sleep disorders, and mental stress[3, 8]. As the statistics show, 100 million people in the United States are being disturbed by noise. In the United Kingdom, 3/4 residents living in big cities (i.e. London and Liverpool) are seriously being affected by noise, even in Stockholm, Sweden, where it is usually considered as a quiet city, 70% people are dis-turbed by noise. Among them, a major part of noise originates from urban traffic. As other countries in the world, China cannot avoid being impacted by terrible urban road traffic noise[3, 6, 9]. Least 10,000 premature deaths occur yearly due to environ-mental noise [9]. The wave – wave interaction effects, seismic background, and/or tur-bulence dominates the noise at VLF (very low frequency band: $1 < f < 20$ Hz), with power spectral density of the pressure field $S(f) \propto f\_4$. Distant shipping noise dominates at LF (low frequency band: $20 < f < 200$ Hz), has a broad spectral peak around 50 Hz, and falls off sharply for $f > 200$ Hz as f_6. At MF (midfrequency band: 200 Hz < f < 50 kHz), noise caused by sea surface agitation typically dominates, with a broad peak within 200 Hz < f < 2 kHz and, beyond f _ 2 kHz, with $S(f) \propto$ f_1.7. Finally, molecular agitation typically dominates the noise at HF (high frequency band: f > 100 kHz), with $S(f) \propto$ f 2[10]. As we can see in figure 1.

Figure 1. Ambient noise spectra summarized by Wenz. (The ordinates are Ln ¼ 10 log10S(f), with respect to the reference value. Add 100 dB to the right-hand scale to obtain Ln in dB re 1 m Pa and 1 Hz.) The Beaufort Force translates to wind speeds, in ms1 , as follows: 1, 0.5–1.5; 2, 2–3; 3, 3.5–5; 5, 8.5–10.5; 8, 17–20. Reproduced from Wenz, G. M. (1962). Acoustic ambient noise in the ocean: Spectra and sources, Journal of the Acoustical So-ciety of America 34, 1936–1955



With the increase in the number of vehicles and population, much more people have been affected by the noise from year to year. In particular, traffic noise sounds greater than city environmental noise and has a bad influence to the residents sur-rounding[8, 11].

Transportation noise is increasingly recognized as a risk factor of human health. Existing reviews have suggested that transportation noise is associated with numerous physical health outcomes including ischemic heart disease, hearing loss, and adverse birth outcomes. Previous reviews have also indicated a relationship between trans-portation noise and mental health[12]. Ambient air quality standards with respect to noise have been specified for different types of areas. For residential areas, the daytime noise should not exceed 55 dB (A) Leq as per these rules. Universities, colleges, schools, libraries, national laboratories, and hospitals come under Silent Zone. It may be men-tioned that these are buildings that require on average quiet conditions but are also at the same time noise sources at certain times, for e.g. student movement in universi-ties[5, 13]. In the cognitive performance context, noise affects the behavior and under-standing of students, and very noisy places are unfavorable for learning and make teaching exhaustive. There have been several studies on the influence of environmen-tal noise upon the learning and working performance. A number of findings have in-dicated that exposure to environmental noise can lead to a decrease in cognitive performance including communication difficulties, impaired attention, increased arousal, learned helplessness, frustration, noise annoyance, and consequences of sleep disturbance on performance[14].

Use of horns, traffic congestion and rapid increase of traffic flow are the main causes of traffic noise enhancement in the urban areas. Menace of noise can be mini-mized if it is detected at the planning stage else it is beyond the economics of optimiza-tion[9, 15].

Observers of the global problem caused by the high rate of noise pollution pro-duced by the automotive and transportation sector, which is deeply rooted in devel-oped countries, and is also present in developing countries such as South America , the research group GISAI - research group in safety and environment and engineering, carried out specific studies of noise pollution due to high noise levels that are exposed to people who are inside and outside the most representative universities in zone 3 fa-cilities, that are located in the province of Chimborazo - Ecuador, such as the ESPOCH (Polytechnic School of Chimborazo, and the UNACH (National University of Chim-borazo), which have around 21,000 thousand students each, developing their usual study activities, for which this is a very important research, to prevent damage on the health of the university community, so the question is: In underdeveloped countries, specifically in Ecuador, are we developing mechanisms to prevent the impact of noise pollution?

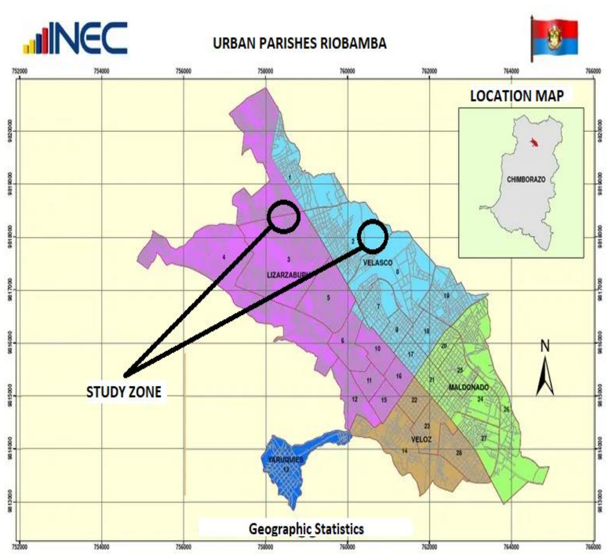
2. Materials and Methods

The Materials and Methods should be described with sufficient details to allow others to replicate and build on the published results. Please note that the publication of your manuscript implicates that you must make all materials, data, computer code, and protocols associated with the publication available to readers. Please disclose at the submission stage any restrictions on the availability of materials or information. New methods and protocols should be described in detail while well-established methods can be briefly described and appropriately cited.

The study was carried out in the province of Chimborazo, Riobamba, according to the figure 2. Specifically it was focused on the parishes of Lizarzaburu, and Velazco where the public institutions are located. In these spaces, the noise study was carried out both within and in the surrounding areas of the institutions. According to the map described below:

- Region Zone N° 3 Sierra Centre, Chimborazo Province
- Canton Riobamba, Velazco y Lizarzaburu

Figure 2. Location map of the most relevant higher education centers in the city of Riobamba, in the par-ishes of Lizarzaburu and Velazco, where the ESPOCH and UNACH are located respectively according to the INEC.



Within the methodologies used in this study, those of scientific research as well as a technical study are highly efficient, within those of scientific research based on the deductive scientific analysis to the practical:

2.1 Quasi-Experimental, Experimental Research: The purpose of experimental re-search is to establish a link between cause and effect, and on the hierarchy of evidence, experimental studies (such as an RCT) provide a higher level of evidence than a QE (Quasi–Experimental) study. To establish causality, a researcher needs to look, the other conditions of causality. These include establishing a relationship between the IV (independent variable) and DV (dependent variable), ensuring temporal antecedence, and determining that there are no alternative explanations. It is easier to meet RCT (these causality requirements), in an than in a QE study because of the amount of con-trol afforded by an RCT design. However, with careful planning, a QE study can be de-signed to meet these requirements[16].

2.2 Measurement and data recording: Noise level data was recorded at georef-erenced points in ESPOCH and UNACH with the use of a professional sound level meter PCE-432. It´s observed in figure 3. The sonometer parameters were set to[16]: Professional sound level meter with GPS (class 1) / Octave band filter / A, B, C and Z weighting range 22 ... 136 db (A) Class 1 Accuracy Frequency range 3 Hz ... 20 kHz Regulations GB / T3785.1-2010 GB / T3785.2-2010 IEC60651: 1979 IEC60804: 2000 IEC61672-1: 2013 ANSI S1.4-1983 ANSI S1.43-1997 Frequency analysis Octave band filter: 8 Hz ... 16 kHz 1/3 octave band filter: 6.3 Hz ... 20 kHz, following the technical recommendations of the Unified Text of the secondary Legislation of the Ministry of Environment (TULSMA, for its acronym in Spanish)[17].

Figure 3. Taking samples of noise levels in the vicinity of the Polytechnic School of Chimborazo ESPOCH

2.3 Planimetry. - The plans granted by the universities for research were re-viewed, in the case of ESPOCH (Figure 4), using specialized drawing and simulation software, modifications were made to obtain the current plan of the place with its re-spective sections, measurements were taken at UNACH (Figure 5), to carry out the planimetry using specialized drawing and simulation software with their respective sections.

Figure 4. Survey of planimetry of the Chimborazo Polytechnic Higher School (ESPOCH), for noise study.

Figure 5. Survey of planimetry of the national university of Chimborazo (UNACH), for noise study

2.4 Noise mapping. – The construction of noise maps by calculation methods requires the collection of geographic data to form the geographic databases, involving specialized technical staff and equipment. Currently, there are collaborative initiatives in information and communication technologies that allow sharing. Environmental noise maps were prepared in the two higher education institutions in the province of Chimborazo using QGIS (Geographic Information Systems) software, that is open ac-cess software, QGIS is made for inexperienced users who want to create their first dig-ital geological map. Nevertheless, it includes basic information on coordinate reference systems is given., implementation of different basemap layers (e.g. raster data, web map services and scanned maps) as background maps. The georeferencing tool for the implementation of scanned maps is also presented[18].

2.5. Monitoring Points. - After attending higher IES (education institutions), visiting the places, the planimetry in which the mesh method is applied at every cer-tain distance would be obtained, considering the geometric divergence to cover the en-tire study area, establishing, once determined the numbers of monitoring points will proceed to locate these points in the planimetries of the HEIs with a marking on the floor and in turn will be referenced on the previously updated printed map.

The method used is traditional Laplacian method Let M=(p,e,f) be a triangular mesh. Where p are vertices, e are edges, and f are triangles of M. The Laplacian opera-tor can be linearly approximated at each vertex by the so-called umbrella-operator as follows:[19].

$$D(p) = \frac{1}{n}\sum_{1\in N(p)}(q_i - p) \qquad (1)$$

2.6 Georeferenced Monitoring Points. - With the planimetry of the IES, the maps were georeferenced with the GPS (Global Positioning System), also taking exter-nal points. From the georeferenced maps, the coordinates of the monitoring points were found, the coordinates of each monitoring point were extracted from the georef-erenced map and an excel table was generated with Point, Longitude, Latitude, and Identification. Both from ESPOCH and UNACH.

2.7 Noise point measurement. - To take samples at each point, a type I sound level meter was used, calibrated, with a weighting and acceptable response for this type of investigation, “The sound level meters directly record the sound pressure level of an acoustic phenomenon, and expresses the result in dB, with a reference sound pressure of 20 x 106. According to the TULSMA book, it is stipulated that the sound level meter must be placed on a tripod at a height ⩾ 1.5 m from the ground, directing the microphone towards the source with an inclination of 45 to 90 degrees, on its hori-zontal plane. During the measurement the operator must be away from the equipment, at least 1 meter”; The noise values were monitored for a month at different times, mornings, and afternoons, on Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday. The time interval to collect the data at each point will be 1 minute. These times were considered to obtain different data to complement the investigation. Data collection sheets called Auditory Pressure Measurement of the IES were made, with the following parameters: point number, location, Maximum SPL, Leq, Minimum SPL (Sound Pressure Level) and observations. Finally, the data collection references of the sound pressure measurements performed were noted.

2.8 Data tabulation and statistical analysis. - Once the noise level data has been obtained at the two universities ESPOCH and UNACH, at the different georefer-enced and located points, they are tabulated in a matrix, using the MINITAB statistical software, programs for various multivariate analyzes[20]. as well as in Excel for the correct statistical analysis, what would be the results to be able to define the mitigation plan in the points where there are inadequate noise levels and that are outside the ad-missible range according to the TULSMA book.

2.9 Noise mitigation plan. - Action plans aiming at fighting traffic[3, 21]. With the noise map with the geo-managed points and the complete statistical study, it is possible to obtain exactly the exposure of the population to environmental noise, in order to adopt the necessary action plans to prevent and reduce environmental noise and, in particular, when Exposure levels may have harmful effects on human health, for which the noise mitigation plan was carried out with action plans consisting of prevention, monitoring and control measures, in addition to having the activities and in the areas where they are. They can be implemented within the Higher Education In-stitutions of the province of Chimborazo in this case the ESPOCH and the UNACH.

3. Results

As we have mentioned, the project was based on carrying out a study of the noise levels that cause the population near the ESPOCH and UNACH, as well as their stu-dents and workers, due to different factors, mainly related to the city's vehicle fleet., as well as the development of a mitigation plan to reduce noise pollution due to high noise levels. For this reason, with the results of this research, it would be delivered to the community, as an important tool in the development of new environmental tech-niques that help in sustainable management and reduction of noise rates.

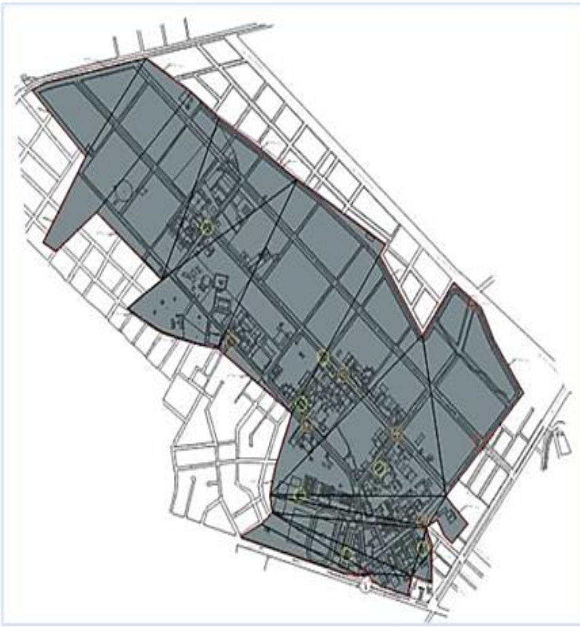
Analysis of variables: the main variables that were detected are the most common and with a repetition rate in cities to increase noise levels, in sectors near universities as in this study, both in ESPOCH and UNACH. The noise from transportations, traffic, civil construction, siren and fireworks, lawn mowing, communication between class break, and music, and other noises are the examples of noise pollution that can affect students ’concentration and learning performance. Every building differs from its noise level allowance according to its function, particularly in educational building, the noise limit is 55 dB inside the classroom.[22, 23].

3.1 Planimetry ESPOCH

For the study, the segmentation of the planimetry of both the ESPOCH (Figure 6) and the UNACH was carried out, to be able to perform the most noise per mesh, as we can see figure 8,9. Which will serve to validate the noise level curves.

This section may be divided by subheadings. It should provide a concise and pre-cise description of the experimental results, their interpretation, as well as the experi-mental conclusions that can be drawn.

Figure 6. Segmentation of areas by means of ESPOCH regular polygons



3.2 Planimetry UNACH

In the same way, the segmentation of the planimetry at the UNACH (Figure 7), was carried out for its subsequent noise mapping by meshes.

Figure 7. Segmentation of areas by means of UNACH regular polygons.

The stable mesh method relates to areas where there is the highest amount of noise within the planimetry. It is considered as 2D limited domain. Two uniform grids were introduced in it with steps H and h (h <H), namely a coarse grid GH and a fine grid Gh. Average noise levels are calculated in the grid cells associated with GH, H-cells. The fine grid with corresponding h-cells is an auxiliary one used for discretiza-tion of the scene. In particular, one can mark building projections by h-points. Thus, it can transit, at least partly, from continuous objects to discrete ones. Geometry sketch is shown in Figure 8,9, it connect two H-cells i and j by the polygon Cij shown in and calculate the number N of h-grid points in-side building projections on horizontal plane (white spots).Building density in the polygon Cijis,[24] this is mathematically calculated as follows:

$$B_{ij} = Nh^2/A(C_{ij}) \qquad (2)$$

When A(Cij) is the area of Cij

3.3 Noise point measurement ESPOCH The mechanism that helps in an automatic way and facilitating the calculation with the QGIS program, free software for noise studies, which is used to obtain the density levels of structures that are found in both the ESPOCH (Figure 8) and the UNACH (Figure 9), this is performed by the mesh method as we can see below:

Figure 8. Points with noise level according to the reference of estimation of crosses with differentiation of densities - mesh method, of the UNACH facilities

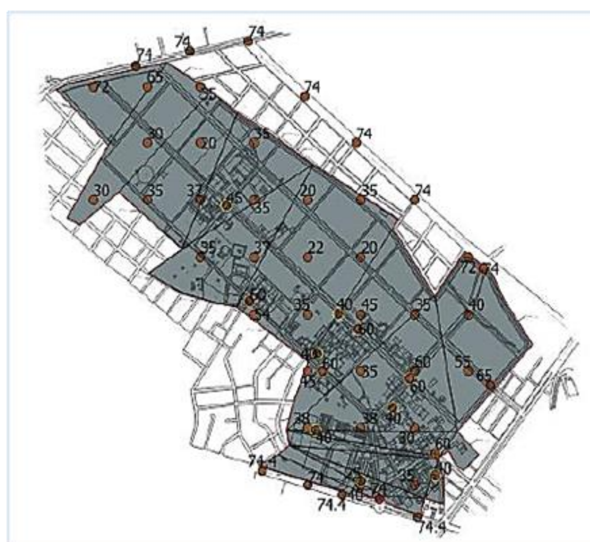
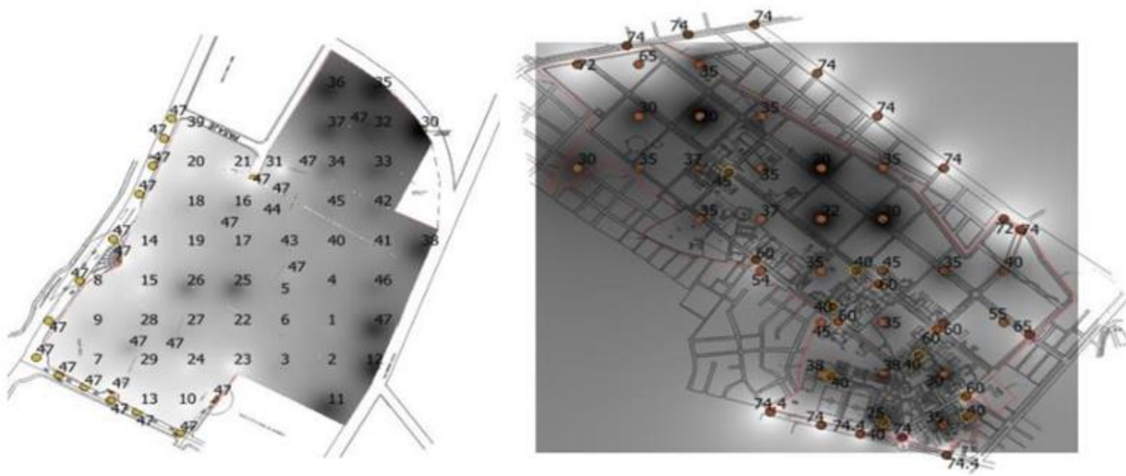
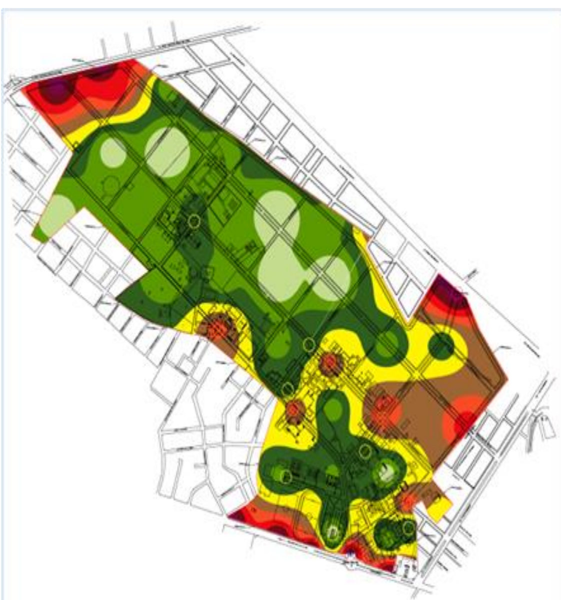


Figure 9. Georeferencing of points of noise levels mesh method according to the density crossing of the in-frastructures and roads of the most representative higher education institutions in zone 3 of Ecuador, survey car-ried out with the QGIS program (Open Source)



3.4 Noise mapping ESPOCH

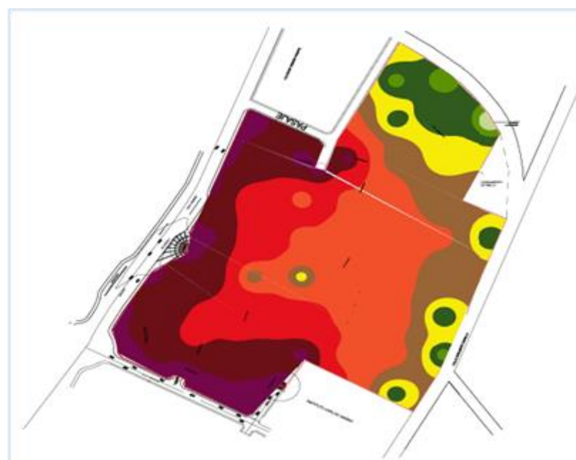
Figure 10. ESPOCH noise map



This noise map is developed based on table 1 of noise margins according to the ISO 1996-2 standard, and the mesh mapping developed in the QGIS, which presents areas with high noise index as we can see in the figure 10 sectors adjacent to the main accesses, where the data collection will be carried out with greater emphasis for the study of noise near the ESPOCH (Figure 10)

3.5 Noise mapping UNACH

Figure 11. UNACH noise map

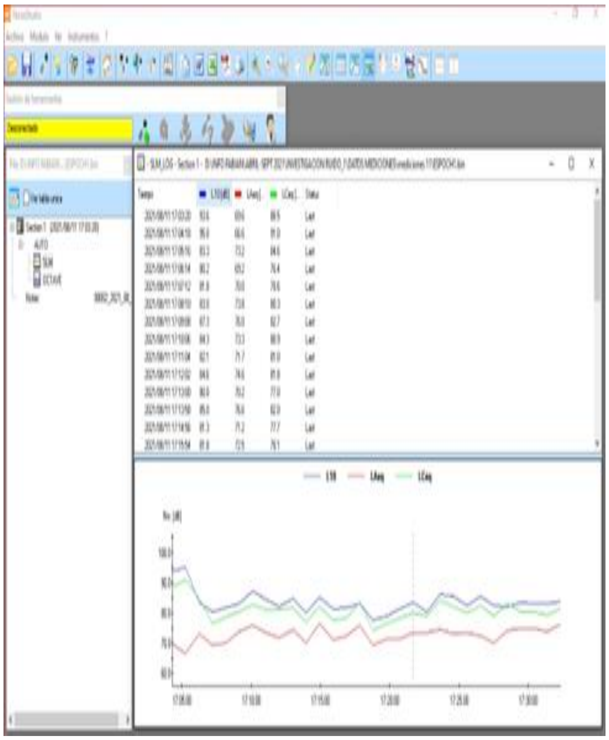


Whe have the same case for the UNACH noise map describing the areas with the highest rate of noise levels, we observe the figure11.

3.6 Recording noise data with the sound meter and dosimeter / Monitoring Points

Similarly, based on the ISO 1996-2 standard for noise levels, the noise map is es-tablished at UNACH, where it is clearly evidenced in figure 12 that the institution's greatest exposure to noise is in the main access in the Avenida Antonio Jose de Sucre, one of the main factors for this level to deteriorate is that it is located in front of the Riobamba shopping center.

Figure 12. Tabulation of data in Noise Studio obtained with the PCE-432 sonometer at the points of greatest influence in the ESPOCH and UNACH.



With the high efficiency class 1 PCE-432 sound level meter, data was collected at the most influential points according to the noise maps of both ESPOCH and UNACH, the PCE-432 provides sound data each two seconds which makes the study have an adequate effectiveness in the averages of the data. These data are tabulated in the NOISESTUDIO, as we can see in figure 12. Data would be statistically analyzed in both excel and MINITAB, later.

The data has been tabulated in Excel to be able to be used in the statistical analy-sis, which, for explanatory reasons specific to the investigation, presents a noise sam-pling at the georeferenced points and the noise map. The graphs are presented only in minitab for a better understanding. Existing maximum noise values of 80 db in the main access of the ESPOCH, as well as minimum values of 40.10 db, in access 3 of the UNACH, the exact behavior of the noise will be represented in the following graphs.(figure 13)

Figure 13. Tabulation sample of data in Excel of the main accesses of the two universities for statistical analysis - data taken in the year 2020 - 2021 in the presence of the covid-19 virus

HORA	12H00 - 13H00	12H00-13H00	11h30-12h30	12h40-13h40	11h30-12h30	12h30-13h30	12h00-13h00
Ruido Minimo (dB)	46,60	40,40	40,10	37,20	51,30	51,80	51,40
Ruido Maximo (dB)	75,90	51,80	77,90	70,80	75,80	75,00	80,50
N°	RUIDO(dB)	RUIDO(dB)	RUIDO(dB)	RUIDO(dB)	RUIDO(dB)	RUIDO(dB)	RUIDO(dB)
1	61,6	47,8	42,9	45	62,3	66,9	70,4
2	62,2	51,3	40,1	52,5	65,4	55,9	68
3	65,5	40,7	48,2	57	65,2	56,8	70,5
4	64	47,7	62,2	51,3	60,8	61,7	67
5	46,6	42,3	54	48,6	63	54,6	67
6	65,7	41,1	44,2	39,1	67,3	54,6	71,6
7	54	43,8	47,4	52,3	62,7	56,4	72,6
8	70,2	47,6	54,8	46,6	68,9	60,8	75,2
9	63,4	40,4	70,7	48,9	72,3	69	66,5
10	55,2	42,6	62,8	37,8	68	70,5	66,6
11	58	46,8	43,7	46,6	68,7	70,2	71,7
12	75,9	45,1	72,1	55,7	67,6	54,7	69,4
13	59,8	44,3	68	50,3	61,5	63	66,9
14	69,7	48,2	67,5	44,1	74,3	65,7	68
15	61,2	46,8	46,6	48,8	60	55,7	66,1
16	64,3	46,3	59,7	56,1	66,3	61,6	58,2
17	63,8	42	65,2	54,5	69,2	59,7	64,7
18	61,2	44,9	67	61,8	71,6	55,9	68,4

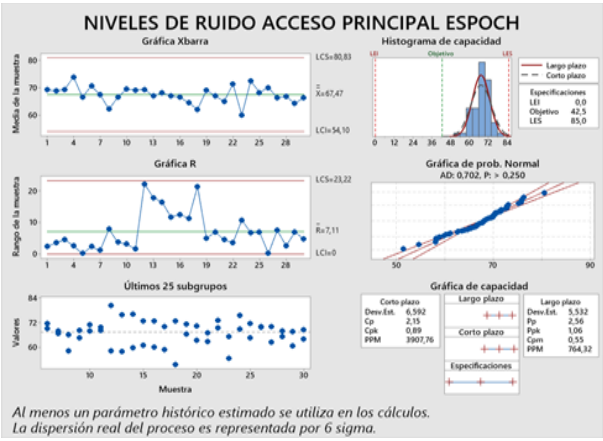
3.7 Statistic Analysis

For the statistical study, the MINITAB program was used due to its benefits for comparative and simultaneous data analysis, in our case of data (Figure 14), on noise levels in areas close to the universities that are in the city of Riobamba.

3.7.1 Main Access – Espoch

Figure 14. Statistical Six Pack analysis of noise levels - with a six-sigma error level in the main entrance ESPOCH.

NOISE LEVELS MAIN ACCESS ESPOCH



At least one estimated historical parameter is used for calculations.

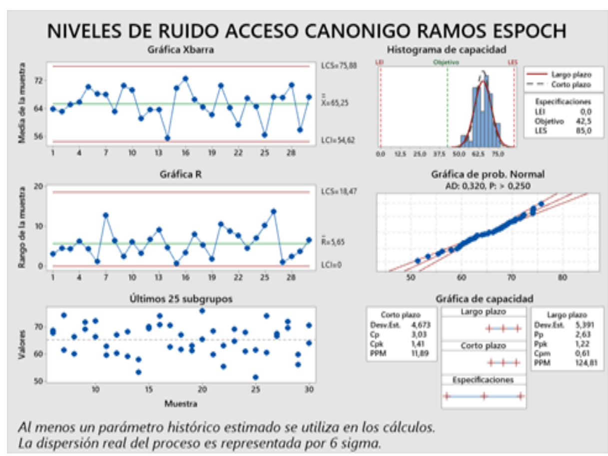
The actual dispersion of the process is represented by 6 sigma

Using the statistical analysis tool by the six pack method that Minitab offers us, we can verify that the noise levels in the main access of the ESPOCH(Figure 15) are adequate and within the parameters, remembering that this study was planned to be carried out in the year 2020 - 2021 but due to the pandemic and the presence of SARS-CoV-2 or known as Covid 19, higher-level institutions such as ESPOCH, UNACH closed their facilities, as well as all vehicular traffic was affected, as well as all The businesses that were in the surroundings had to close, therefore the noise levels presented in the tables are acceptable, a scope of this study will have to be carried out when the pandemic has definitively ended. Well, the data obtained with these circum-stances we can see that in relation to the X-bar graph an upper limit is obtained (LCU = 80, 83 db), as well as in the lower limit (LCL = 54.10 db) with an average (LC = 67.47 db), which according to these data would be within the permissible ranges which would contrast with the noise maps but is obviously affected by the pandemic, in the R-bar graph we see an upper limit (LCU = 23.22 db), as well as in the lower limit (LCL = 0 db) with an average (LC = 7.11 db), which in the same way the variability from 0 to 23 with an average of 7 tells us that there are not many significant changes, it is also affected by the pandemic. There is also in the sixpack a very regular data scatter plot due to the variability of the data, and finally in this first analysis we can see that in the capacity histogram it is shifted from the mean to the right like the block diagrams , clearly giving us an upward trend in the noise level data that is also confirmed by the CP = 2.15, being greater than 1 indicates that the trend will indeed be upward, that is, at the end of the pandemic and returning to a regular movement these levels would exceed the permissible levels according to the TULSMA which is 80 db.

3.7.2 Canonigo Ramos - Espoch Access

Figure 15. Statistical Six Pack analysis of noise levels - with six sigma error level in access Canonigo Ra-mos ESPOCH

NOISE LEVELS MAIN ACCESS ESPOCH CANONIGO RAMOS



At least one estimated historical parameter is used for calculations.

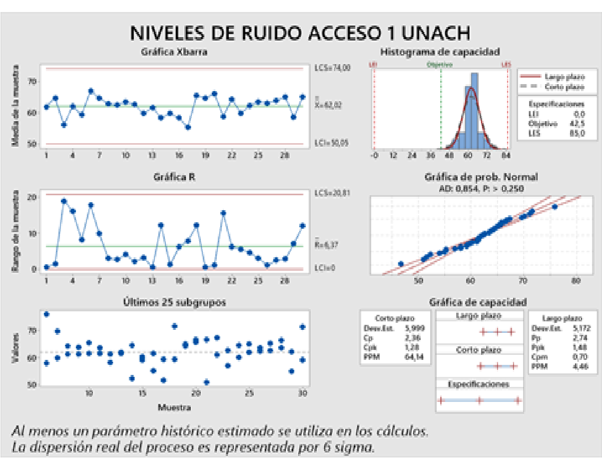
The actual dispersion of the process is represented by 6 sigma

While in the access of the Canonigo Ramos of the ESPOCH(Figure 16), it exhibits a very similar behavior, obviously due to the pandemic, well we can observe that ac-cording to the X-bar graph an upper limit is obtained (LCU = 75, 88 db), as well as in the lower limit (LCL = 54.62 db) with an average (LC = 65.25 db), which would likewise contrast with the noise maps due to the impact of the pandemic, in the R-bar graph we see a upper limit (LCU = 18.47 db), as well as in the lower limit (LCL = 0 db) with an average (LC = 5.65 db), well the variability from 0 to 18 with an average of 6 tells us There are not many significant changes, the scatter plot of noise data is regular, like-wise the capacity histogram is shifted from the mean to the right as well as the block diagrams, clearly giving us an upward trend in the data. of noise levels, which is also confirmed by the CP = 3.03, since it is greater than 1, it indicates that the effective trend entity will be on the rise.

3.7.3 Access 1 - Unach

Figure 16. Six Pack statistical analysis of noise levels - with six sigma error level at access 1 UNACH

NOISE LEVELS MAIN ACCESS 1 UNACH



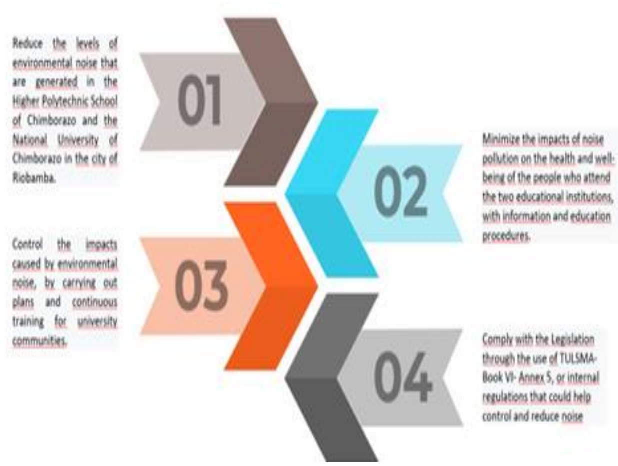
At least one estimated historical parameter is used for calculations.

The actual dispersion of the process is represented by 6 sigma

Finally, the one in the main access of the UNACH or access 1(Figure 17), which is in front of the shopping center, presents a very similar behavior, due to the pandemic also the shopping centers had to close their doors, the vehicular influx decreased in the sector, as we can well observe that according to the X-bar graph an upper limit is ob-tained (LCU = 74 db), as well as in the lower limit (LCL = 50.05 db) with an average (LC = 62.02 db), which is equal to In this way, it would contrast with the noise maps due to the impact of the pandemic, in the R-bar graph we see an upper limit (LCU = 20.81 db), as well as in the lower limit (LCL = 0 db) with an average (LC = 6.37 db), well the variability from 0 to 20 with an average of 6 tells us that there are not many signif-icant changes, the scatter plot of noise data is regular, likewise the capacity histogram is displaced from the mean to the right like the block diagrams, clearly giving us a Noise level data rises upwards, which is also confirmed by CP = 2.36, since it is greater than 1, it indicates that the trend will indeed be upward.

3.8. Summary of the mitigation plan espochunach noise level study

Figure 17. Summary of the mitigation plan ESPOCH - UNACH noise level study



3.8.1 Activities to reduce noise from mobile sources

• Management with the Directorate of Management of Mobility, Traffic and Transportation of Riobamba.

• Training for heavy and light transport drivers on environmental pollution issues.

• Maintenance of the Road Surface.

• Vehicle inspection.

• Traffic planning and management.

• Prohibition of vehicular traffic.

3.8.2 Activities to reduce noise human training plan

• Plant live barriers with ornamental plants and gardens adjacent to the enclo-sures.

• Plant trees of moderate height in the flowerbeds of the main avenues

• Propose a remodeling study of the enclosures.

4. Discussion

It is clear that the values of the data collection have been affected by the pandem-ic since it does not reflect the real impact that the vehicle fleet has as well as the large influx of people and businesses that are usually around the universities, This has af-fected the expected indices since, as we have commented in the study, it was planned for the period 2020 - 2021 but it was affected by covid-19, it will be necessary to make a scope of this present study and carry out a post-covid comparison 19. And verify the trend that the tables presented to us in the statistical analysis.

Noise in developing countries in Latin America, as well as in areas within the countries that make it up, noise studies are not carried out, or the studies are almost non-existent, so we know that high noise levels cause stress in many of the cases of psychosocial problems, such as, for example, the levels of abuse in Latin American so-cieties are increasing even more, for this reason it is essential to collect more infor-mation as well as carry out more in-depth studies of noise, as well as, based on these data obtained, carry out complementary psychosocial studies that can address sensi-tive issues that are deteriorating human relations in Latin America

5. Conclusions

The variables analyzed such as the A-weighted equivalent continuous sound pressure level, the spectrum of noise frequencies and the temporal evolution of the noise, characterize the noise and present alternatives in its measurement, since the sound emission level was the most important to measure. For which last generation equipment was used.

The critical points were distributed based on a noise analysis throughout the uni-versity campus, defining the main entrances as those with the highest incidence of noise damage, mainly in the city's vehicle fleet.

In the accesses with the highest vehicular influx of both the ESPOCH and the UNACH, we observe according to the X Bar graphs, the data has a normal behavior in reference to the average around 65 dB, we must remember that the maximum value of decibels allowed By executive decree 2393 it is 85 dB, we could say that it is within what is permissible, we take into account a range from 0 to 85 dB obtaining acceptable means around 43 dB as we can see in the graphs, on the other hand we can see that The mean of the data obtained is above the expected mean, so we should take into account that it is a trend towards the upper limit, which could be expected to increase with the decrease in the pandemic. On the other hand, the R Bar graph, the mean of the range is 5, which shows a trend that the data obtained is from the mean downwards. And fi-nally with the scatter diagram and the data of the standard deviation in many of the cases around 5 we can see that there is a great dispersion with respect to its central trend line, for which we see that there is a very high variability in the fluctuation in the data.

The noise maps generated under the QGIS software are simulations carried out with data from noise measurements at the boundaries of the territory of the HEIs, that is, at each main entrance of the universities under study, because these sectors are close to avenues of high vehicular load in the city of Riobamba, the results showed maximum values of 92 dB for the ESPOCH and 89 dB for the UNACH, while in central sectors of both universities the noise pollution decreases considerably to 50 dB to a value of 35 dB, due to the remoteness of these avenues.

The mitigation plan developed will allow the reduction of environmental noise levels that are generated in the Polytechnic School of Chimborazo and the National University of Chimborazo of the city of Riobamba, by means of plans and procedures that allow minimizing the impacts to the health and well-being of the people who at-tend the two educational institutions, with compliance with current environmental regulations (TULSMA-Book VI- Annex 5) or with the application of internal regula-tions that could help control and reduce noise.

6. Patents

Author Contributions:

CR contributed in the noise mapping, as well as in the field data collection of the noise levels in the areas framed within the study, EC contributed in the statistical study of the data, as well as in the field data collection of noise levels in the areas framed within the study, FB contributed in the noise mapping, in the mitigation plan, as well as in the field data collection of noise levels in the areas framed within the study, MB social affectation, JM contributed in the noise mapping, as well as in the revision of the article or its translation into the English language.

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Data Availability Statement: Not Apply

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Appendix A Not Apply

Appendix B Not Apply

Reference

[1] Zhu Caixia, Ma Fuqin, Zhou Yide and Song Gaoju, "The Loss of Traffic Noise in Chinese Key Cities," pp. 622-625, Apr 2009.

[2] O.S. Oyedepo and A.A. Saadu, "Evaluation and analysis of noise levels in Ilorin metropolis, Nigeria," En-viron Monit Assess, vol. 160, pp. 563-577, Feb 06,. 2009.

[3] N. Garg and S. Maji, "A retrospective view of noise pollution control policy in India: status, proposed revi-sions and control measures," Current Science (Bangalore), vol. 111, pp. 29-38, Jul 10,. 2016.

[4] J. Khan, M. Ketzel, K. Kakosimos, M. Sørensen and S.S. Jensen, "Road traffic air and noise pollution expo-sure assessment – A review of tools and techniques," The Science of the Total Environment, vol. 634, pp. 661-676, Sep 01,. 2018.

[5] B. Sathio, K.M. Brohi and R. Laghari, "To analyze the effect of road traffic noise on surrounding buildings," AIP Conference Proceedings, vol. 2119, Jul 11,. 2019.

[6] Q. Wu, X. Zhang and G. Cao, "Study on the prevention and control measures of China's urban road traffic noise pollution," .

[7] J. Hegewald, M. Schubert, A. Freiberg, K. Romero Starke, F. Augustin, S.G. Riedel-Heller, H. Zeeb and A. Seidler, "Traffic Noise and Mental Health: A Systematic Review and Meta-Analysis," International Journal of Environmental Research and Public Health, vol. 17, pp. 6175, Aug 25,. 2020.

[8] A. Moteallemi, B. Bina and S. Mortezaie, "Effects of noise pollution on Samen district residents in Mashhad city," Environmental Health Engineering and Management, vol. 5, pp. 23-27, Jan 13,. 2018.

[9] J. Khan, M. Ketzel, K. Kakosimos, M. Sørensen and S.S. Jensen, "Road traffic air and noise pollution expo-sure assessment –

A review of tools and techniques," The Science of the Total Environment, vol. 634, pp. 661-676, Sep 01,. 2018.

[10] I. Dyer, "Acoustic Noise," Encyclopedia of Ocean Sciences, pp. 250, 2019.

[11] Zhu Caixia, Ma Fuqin, Zhou Yide and Song Gaoju, "The Loss of Traffic Noise in Chinese Key Cities," pp. 622-625, Apr 2009.

[12] Y. Lan, H. Roberts, M. Kwan and M. Helbich, "Transportation noise exposure and anxiety: A systematic review and meta-analysis," Environmental Research, vol. 191, pp. 110118, Dec. 2020.

[13] D. Thattai, J.S. Sudarsan, R. Sathyanathan and V. Ramasamy, "Analysis of noise pollution level in a Uni-versity campus in South India," IOP Conference Series. Earth and Environmental Science, vol. 80, pp. 12053, Jul 01,. 2017.

[14] D. Çolakkadıoğlu, M. Yücel, B. Kahveci and Ö Aydınol, "Determination of noise pollution on university campuses: a case study at Çukurova University campus in Turkey," Environ Monit Assess, vol. 190, pp. 1-14, Mar 09,. 2018.

[15] A. K. Sahu, M. Pradhan, C. R. Mohanty and P. K. Pradhan, "Assessment of Traffic Noise Pollution in Burla Town, India; An Inclusive Annoyance Study," Sound & Vibration, vol. 54, pp. 27-42, 2020.

[16] J.M. Olivera, L.A. Rocha, E. Ruiz, V.I. Rotger and M.C. Herrera, "New approach to evaluate Acoustic Pollution in hospital environments," Journal of Physics. Conference Series, vol. 477, pp. 12019, Dec 31,. 2013.

[17] M.A. Zambrano-Monserrate and M.A. Ruano, "Does environmental noise affect housing rental prices in developing countries? Evidence from Ecuador," Land use Policy, vol. 87, pp. 104059, Sep. 2019.

[18] G.H. Erharter and M. Palzer-Khomenko, "DiGeo: Introduction and a new tutorial to geological maps with QGIS 3.X," Austrian Journal of Earth Sciences, vol. 111, pp. 223, 2018.

[19] D. Hyeon and T. WhangBo, "Noise reduction for mesh smoothing of 3D mesh data," International JOURNAL OF CONTENTS, vol. 5, pp. 1-6, 2009.

[20] E.E. Bassett, S.P. Brooks and B.J.T. Morgan, "MINITAB Multivariate Macros," Journal of the Royal Statis-tical Society. Series C (Applied Statistics), vol. 45, pp. 235-245, Jan 01,. 1996.

[21] A. Can, A. L'Hostis, P. Aumond, D. Botteldooren, M.C. Coelho, C. Guarnaccia and J. Kang, "The fu-ture of urban sound environments: Impacting mobility trends and insights for noise assessment and mitiga-tion," Applied Acoustics, vol. 170, pp. 107518, Dec 15,. 2020.

[22] N. Amran and N. Hillary Christy Damanik, "Evaluation of noise level in architecture department build-ing in University of Sumatera Utara," IOP Conference Series. Earth and Environmental Science, vol. 126, pp. 12042, Mar 01,. 2018.

[23] E.A.A. Julius, Y.B. John and A. Akintunde, "Akintunde2020_Article_NoiseLevelMappingInUniversityO," .

[24] A. Ziv and E. Solov’eva, "Approximate noise maps as instrument for evaluation of the city environment quality," Noise Mapping, vol. 8, pp. 260-267, Sep 01,. 2021.

[25] Anonymous "iso-1996-2," .