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A GENERAL VIEW REGARDING THE ENVIROMENTAL NOISE IN MEXICO

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ABSTRACT

Pollution caused by environmental noise is known as a corresponding set of noise emissions which are developed in an urban context. It is also imperative to mention that its characteristics detrimentally affect the quality of life of human beings, as well as intervening in the devaluation of buildings and attack ecosystem integrity. This article compiles a wide variety of terms and vital key tools which are necessary to approach the subject matter and presents a worldwide overview of the current condition of environmental noise pollution in Mexico. The intended purpose of this paper is to function as a guide for the general knowledge and development of projects which might successfully help with the identification of feasible risk scenarios in order to considerate measurement, prevention, mitigation and control strategies.

KEY WORDS: Environmental noise, Acoustic pollution, Noise map, Noise control.

Introduction

Environmental noise is all that undesired sound or set of sounds that are simultaneously generated and emitted by diverse anthropic sources which produce health impairment in human lives (Murphy & King 2014). Consequently, detrimental effects produced by this phenomenon have been deeply explored, resulting in damages related to chronic degenerative conditions, such as hearing loss (Hernández et al., 2019; Ihemeje & Onyelowe 2021; Radun et al., 2022; Li et al., 2016); the influence in neuronal degenerative processes which increase the possibility of aggravating conditions like Alzheimer or dementia (Hahad, et al., 2022; Eze, et al., 2020); or the evolution of sleep disturbances that tend to trigger medical conditions such as hypertension and diabetes (Eriksson & Pershagen 2018; Basner et al., 2014; Basner & McGuire, 2018). In this sense, it is estimated that only 3% of the cases of arterial occlusion are attributable to environmental noise emissions coming from traffic (Münzel et al, 2014). On the other hand, exposures up to 65 dB Laeq of environmental noise have demonstrated increases the blood pressure between 6.2 and 7.4 mm of Hg, systolic and diastolic respectively (Eriksson & Pershagen 2018).

Economically, property prices have been a subject of inquiry. As a result, it exists a loss of 30% of the value of buildings located near noisy environments. Moreover, it is presumed that for every 1% of the increase in the level of noise pollution, the lot loses 1.3% of its price annually (Kuehnel & Moeckel 2020). Levels of 45, 50 y 55 dBA generate decreases of 1.6%, 3.7% and 4.3% respectively on the price of houses compared to prices in sectors with levels that do not exceed 40 dBA (Lozhkina, et al., 2020). Within the ecosystem, environmental noise has been identified as an agent that contributes to habitat fragmentation (Nakano, et al., 2018). Considering the above, an influence regarding the distribution and structure of community species has been generated, thus affecting their demographic dynamic (Kunc, et al., 2016).

Sound, Noise and Environmental Noise

The terms 'noise' and 'sound' are generally used with no distinction at all; however, they are not synonyms. In this way, to comprehend technical language it is pivotal to contrast the difference between these two words, as well as essential concepts and tools which are involved in the problematic.

Sound

Sound is a physical phenomenon that involves a dissipation process of energy waves that produces the movement of matter from one point to another, all of this through a substance which serves as conduit (Foreman 2012).

Noise

Noise concept is entirely correlated to every individual human´s perception according to its intensity level. In a general way, noise is described as an undesired sound that incurs discomfort, dissatisfaction or adverse health effects (Poslonec-Petri et al., 2016). Alternatively, Mexican normativity stablishes noise as a sonorous disturbance. The above is a clear result of a set of sounds which are emitted by

diverse sources and influenced by cultural, mechanical and microclimatic aspects within a certain area (NOM-AA-62-1979, Determination of ambient noise levels).

Environmental Noise

Environmental noise is a pollution phenomenon which is developed from an anthropocentric approach. It is defined as an undesired sound coming from human activities that causes declining health and quality of life due to its intensity or prevalence, attributable to combined sources such as industry, business, transportation or leisure activities (Murphy & King 2014). Conversely, another concept describes it as an anthropic outside noise, unwanted or harmful, based on its source and intensity, considering road, air and rail traffic noise, and noise generated by industrial areas (UE 2002). In Mexico, the meaning owns a physical approach which is described as a sonic disturbance that involves mechanical elements of acoustic reflection, as well as the effects that meteorological conditions can contribute in the sound propagation (NOM-AA-62-1979, Determination of environmental noise levels).

Soundscape

A soundscape is a group of sounds belonging to an acoustic environment that can be perceived or experienced by any individual. This concept takes part in a new and defining approach within the bounds of environmental noise pollution study (Hyun In & Jin Yong 2021). This concept contributes to acknowledging the fact that in the context of the relationship between human beings and their surroundings, noise possesses a crucial impact. As a result, in the search for an optimal soundscape, positive conditions regarding the interaction and incorporation of individuals with cities must be encouraged (German & Santillán 2006).

Environmental Noise Indicators

Indicators allow to synthesize data volume, which is a result of acoustic measurements; moreover, they function as instruments that contribute with the description of soundscapes and are useful to evaluate control and alleviation plans (Murphy & King 2014). The basis indicator to calculate noise and determine pollution degree of a particular area is defined within the ISO 1999 standard, which is Equivalent Continuous Sound Level L_{eq} (Mariscal, et al., 2014). By doing so, since noise measurement is achieved based on human hearing response, a setting denominated weighting A is implemented. For this reason, the reference indicator that is used to describe the recording of that range is represented as $L_{Aeq,}$ which takes as a reference value the minimum wave variation that the human ear is capable of detecting (Mariscal et al.,2014) (Zuo, et al., 2016). However, other indicators commonly used are those called L_{den}, whose designation is due to the sum of sound levels occurring over a day: $L_{day,}$ $L_{eve,}$ L_{night} respectively. These levels are commonly used to estimate the general discomfort produced by noise in urban areas that are mainly associated with traffic during a day (Murphy & King, 2014) (Khan, et al., 2018).

Noise Maps

Noise maps are the graphical representation of noise levels distribution (Wawa & Mulaku 2015). Besides, noise maps provide a clear and effortless picture to understand the noise problematics, as well as being a great support to effectively comprehend the spatial perspective of pollution. For its development, it is required to begin with information obtained from in situ measures (Posloncec-Petri, et al., 2016). These measures entail the delimitation of the area of study, sampling representative points and the use of sound level meter, which is a measuring instrument for the recording of noise level based on pre-existing indicators (Murphy & King 2014) (Ilić et al., 2018) (El-Sharkawy & Alsubaie 2014). The study´s scope might determine the data volume that must be gathered, which may include: noise measurements, density of traffic flow or characteristics of the structures that represent the context (Wawa & Mulaku 2015).

Data and Software Modeling

Through an interpolation technique, in situ measurement data are correlated in order to calculate the level of unknown noises. Nowadays, there are two main prevalent methods: IDW method (Inverse Distance Weighting) and Ordinary Kriging Model (Murillo et al., 2012) (Pilkington & Shamsipour 2014). At the same time, the most popular software used to generate representative noise contours are: SoundPLAN, CadnaA and TRANEX (Khan et al, 2018). Nevertheless, there is an extensive repertoire of other tools designed to work as support to conduct estimations for noise maps such as ArcGIS, Predictor LimA Suite Type 7810, 7815 Noise Explorer, Geonetwork (Ilić et al., 2018; Wawa & Mulaku 2015; Martínez 2017; Torres & Romero 2014).

Environmental Noise in Mexico

Environmental noise is quite a new subject of matter in Mexico, and at the same time, the development of the first noise map focused on the metropolitan area in Mexico City is emerging, as well as the inception of continuous monitoring of environmental noise pollution coming from traffic on main roads (Rodríguez et al., 2016). Moreover, this project has sparked interest that motivates further studies related to measuring noise levels in various regions of the country.

Levels of environmental noise have been measured in Queretaro city, obtaining data that presents the fact that levels within city sectors exceed restrictions that have been previously established by the World Health Organization, as well as those acceptable limits certified by NOM-081-SEMARNAT-1994. However, authors highlight the lack of legal instruments that acknowledge environmental noise as a problematic outside industrial contexts, all of this from a current perspective. The above is also considered since the classification of stationary and mobile sources are not adapted to the pollution phenomenon that is developed (Peñaloza et al., 2016).

Furthermore, based on the Urban Development Plan, noise levels of traffic emitted in main access roads in Chihuahua have been determined. The selected vulnerable areas have been established by indicators of population density and the distribution of housing,

commercial, educational, service, health and industrial zones that were contemplated in the plan. Besides, it is confirmed that noise levels exceed limits previously established by the World Health Organization and 45% of these issues surpass limits settled by Mexican normativity (Olague et al., 2016).

Rodríguez (2015), distinguishes communicative strategies that are designed for the consciousness regarding acoustic pollution and public disinformation as consequence of a limited communication plan, thus observing a restricted dissemination of the problematic; all of the above being a minor aspect. Conversely, his analysis of the Mexican Regulatory Framework states some interpretation issues such as zoning, soundscapes and permissible levels, revealing the lack of relevance of the regulations in relation to the real environment where the problem develops. Public areas in Azcapotzalco council have been examined under the purpose of searching for strategic solutions; in this way, with the aid of noise maps, scenarios to consider have been projected for a better contemplation of the different public policies such as the resolution of environmental noise level decrease, mainly of traffic, in "Jardín Hidalgo". As a result, strategic pedestrianization concerning streets and avenues has theoretically been demonstrated since it considerably impacts on the decrease of acoustic pollution; additionally, it was exemplified that environmental noise is greatly powered by informal trade propagation. In this respect, the chronological analysis of the noise maps presented by these authors demonstrated how the relocation actions within informal trade supplies an improvement of the soundscape of specific areas (Rodríguez et al., 2016).

Alfie and Salinas (2017) also scrutinized resolutions to the problematic of environmental noise in Mexico City with the aim to explore and find out solutions which help reducing pollution levels from a view based on the concept denominated Walkable City[2]. They also describe the relationship between environmental noise and the urban means of transportation in the city and emphasize the deficiency of politic policies specifically developed to address the problem. Furthermore, by means of a historical analysis of the noise pollution levels in the city's historical center and the implementation of pedestrian corridors, these authors explain the fact that pedestrianization of specific areas has a positive impact on the decrease of environmental noise in a medium term within a 5-year period.

Moreover, open discussion forums have been performed based on a qualitative approach under the purpose of analyzing the lack of consciousness and dimensioning of the environmental noise problematic compared to other types of pollution. Also, this study demonstrates a relationship between the perception of the environmental noise level as a function of the socioeconomic status of the areas of the city. Participants described urban neighborhoods of low socioeconomic level as the noisiest ones, since they produce wide and scattered emissions, all

[2] Ciudad Caminable (in Spanish)

originated from an anthropic perspective; middle class neighborhoods were defined as adversely affected by noised coming from road traffic; finally, residential neighborhoods were ranked as undisturbed areas with occasional environmental noise (Rodríguez & Juárez, 2020).

Conclusions

The information presented in this article provides crucial concepts, as well as necessary tools to comprehend technical language mainly used in the study of environmental noise. Moreover, these terms are required to recognize the impacts that this phenomenon produces regarding sustainable development axes, which functions as a factor of risk that negatively affects the quality of human beings' lives.

The study of environmental noise within Mexican public areas exposes the appearance of the pollution phenomenon in national territory by determining the levels that exceed the norms and state the public perception regarding to the problem; nevertheless, they still represent a new subject of matter, thus hampered educative, technical and legal limitations that constrains the depth of its appropriately study.

Environmental noise is a complex topic that encourages the development of an approach focused on multidisciplinary research and participation. The aforementioned aims to increase knowledge, prospect strategies and design efficient solutions that are highlighted in terms of relevance within educational plans, especially governmental ones. These plans expect to place the study of this phenomenon with the same importance as other forms of pollution that threaten public welfare and environmental balance.

References

Alfie Cohen, Miriam; Salinas Castillo, Osvaldo (2017). Ruido en la ciudad. Contaminación auditiva y ciudad caminable Estudios demográficos y urbanos, vol. 32, núm. 1, El Colegio de México, Disponible en: http://www.redalyc.org/articulo.oa?id=31251073003

Basner M, Babisch W, Davis A, Brink M, Clark C, Janssen S, Stansfeld S. (2014). Auditory and non-auditory effects of noise on health. Lancet. Apr 12;383(9925):1325-1332. https://doi.org/10.1016/S0140-6736(13)61613-X.

Basner M, McGuire S. (2018) WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep. Int J Environ Res Public Health. Mar 14;15(3):519. doi: 10.3390/ijerph15030519

Elsharkawy, M. Y Alsubaie, A. (2014). Study Of Environmental Noise Pollution In The University Of Dammam Campus. Saudi Journal Of Medicine & Medical Sciences. 2. 178-184. https://doi.org/10.4103/1658-631X.142532

Eriksson, C., y Pershagen, G. (2018). Biological Mechanisms Related To Cardiovascular And Metabolic Effects By Environmental Noise. https://www.euro.who.int/_data/assets/pdf_file/0004/378076/review-noise-bio-effects-eng.pdf

Eze, IC; Foraster, M; Schaffner, E; Vienneau, D; Pieren, R; Imboden, M; Wunderli, JM; Cajochen, C; Brink, M; Röösli, M. y Probst-Hensch N. (2020). Incidence of depression in relation to transportation noise exposure and noise annoyance in the SAPALDIA study. Environ Int. Nov; 144:106014. https://doi.org/10.1016/j.envint.2020.106014

Foreman, J. (2012). Sound Analysis And Noise Control. University Of Western Ontario, Faculty Of Engineering Science. Canada.

German González, Miriam y Santillán, Arturo, O. (2006). Del Concepto de Ruido Urbano al de Paisaje Sonoro. Bitácora Urbano/Territorial, 10 (1), 39 – 52.

Hahad, Omar; Bayo Jiménez, María Teresa; Kuntic, Marin; Frenis, Katie; Steven, Sebastian; Daiber, Andreas y Münzel, Thomas. (2022). Cerebral consequences of environmental noise exposure. Environment International. Volume165, 107306, SSN 0160-4120, https://doi.org/10.1016/j.envint.2022.107306 .

Hernández-Peña, Odalys; Hernández-Montero, Gisel; y López-Rodríguez, Ernesto. (2019). Noise and health. Revista Cubana de Medicina Militar, 48(4), e431. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0138-65572019000400019&lng=es&tlng=en.

Hyun In, Jo y Jin Yong, Jeon. (2021). Urban soundscape categorization based on individual recognition, perception, and assessment of sound environments Landscape and Urban Planning, Volume 216. 104241. ISSN 0169-2046. https://doi.org/10.1016/j.landurbplan.2021.104241.

Ihemeje, James y Onyelowe – Kennedy, C. (2021). State-of-the-art review on the assessment and modelling of traffic noise intensity on roadside dwellers: The Port Harcourt, Nigeria case. Cleaner Engineering and Technology. Volume 5. 100328. ISSN 2666-7908. https://doi.org/10.1016/j.clet.2021.100328.

Ilić, P., Markic, D. Y Bjelić, S. (2018). Measuring And Mapping Noise Pollution In The City Of Banja Luka. Archives For Technical Sciences. 18. 89-96. https://doi.org/10.7251/Afts.2018.1018.089i.

Khan, J., Ketzel, M., Kakosimos, K., Sørensen, M., y Jensen, S. (2018). Road Traffic Air And Noise Pollution Exposure Assessment – A Review Of Tools And Techniques. Science Of The Total Environment. 634. https://doi.org/10.1016/j.scitotenv.2018.03.374

Kuehnel, Nico y Moeckel, Rolf. (2020). Impact of simulation-based traffic noise on rent prices. Transportation Research Part D: Transport and Environment. Volume 78.102191. ISSN 1361-9209. https://doi.org/10.1016/j.trd.2019.11.020.

Kunc, HP; McLaughlin, KE y Schmidt R. (2016) Aquatic noise pollution: implications for individuals, populations, and ecosystems. Proc. R. Soc. B 283: 20160839. http://dx.doi.org/10.1098/rspb.2016.0839

Li, Q., Qiao, F., y Yu, L. (2016). Impacts Of Pavement Types On In-Vehicle Noise And Human Health. Journal Of The Air And Waste Management Association, 66(1), 87–96. Https://Doi.Org/10.1080/10962247.2015.1119217

Lozhkina, Olga; Lozhkin, Vladimir; Vorontsov, Ivan y Druzhinin, Petr. (2020). Evaluation of extreme traffic noise as hazardous living environment factor in Saint Petersburg. Transportation Research Procedia. Volume 50,pp. 389-396,ISSN 2352-1465. https://doi.org/10.1016/j.trpro.2020.10.046.

Mariscal, J. A., Fernández, J. Á., Cañada, J., y Gadeo, M. Á. (2014). Prototipo Experimental Para La Monitorización De Ruido En Tiempo Real En Entornos Urbanos. In Fycma (Palacio De Ferias Y Congresos De Málaga) (Ed.), Convocatoria De Comunicaciones Y 2a Bienal De Proyectos De Edificación Y Urbanismo Sostenible, pp 17. Http://Igc.Malaga.Eu/Opencms/Export/Sites/Igc/.Galeria-Descargas/B5ee1242-C934-11e7-80be-005056935053/05.-Prototipo-Experimental-Para-La-Monitorizacion-De-Ruido-En-Tiempo-Real-En-Entornos-Urbanos.Pdf

Martínez, J. M. (2017). Evaluación Del Ruido En Cuenca A 2015. Avances En Ciencias E Ingenierías, 9(15). Https://Doi.Org/10.18272/Aci.V9i15.711

Münzel, T., Gori, T., Babisch, W., y Basner, M. (2014). Cardiovascular Effects Of Environmental Noise Exposure. European Heart Journal. Oxford University Press. Https://Doi.Org/10.1093/Eurheartj/Ehu030

Murillo I., Ortega J., Carrillo A., Pardo J. y Rendón, D. (2012). COMPARACIÓN DE MÉTODOS DE INTERPOLACIÓN PARA LA GENERACIÓN DE MAPAS DE RUIDO EN ENTORNOS URBANOS. Ing. Usbmed (Vol. 3, Pp. 2027–5846).

Murphy, E. y King, E. (2014). Environmental Noise Pollution: Noise Mapping, Public Health, And Policy. 1-268

Nakano, Yurika; Senzaki, Masayuki; Ishiyama, Nobuo; Yamanaka, Satoshi; Miura, Kazuki y Nakamura, Futoshi. (2018). Noise pollution alters matrix permeability for dispersing anurans: Differential effects among land covers. Global Ecology and Conservation. Volume 16,e00484,ISSN 2351-9894. https://doi.org/10.1016/j.gecco.2018.e00484.

Norma Oficial Mexicana NMX-AA-062-1979. Acústica- Determinación de los niveles de ruido ambiental. DOF: 02/08/1979. https://dof.gob.mx/nota_detalle.php?codigo=4828986&fecha=02/08/1979#gsc.tab=0

Olague-Caballero, Cecilia Olivia; Wenglas-Lara, Gilberto Y Duarte-Rodriguez, José Guillermo. (2016). Contaminación por ruido en carreteras de acceso a la ciudad de Chihuahua. CienciaUAT [online]. vol.11, n.1, pp.101-115. ISSN 2007-7858. https://www.scielo.org.mx/pdf/cuat/v11n1/2007-7858-cuat-11-01-00101.pdf

Peñaloza Pineda, Ivan; Flores Gutiérrez, Avatar y Hernández Alvarado, Margarita Josefina. (2016). Contaminación acústica en la zona 3 de la ciudad de Querétaro: comparación de los niveles de ruido reales y los apreciados por los habitantes. Entreciencias: diálogos en la Sociedad del Conocimiento, vol. 4, núm. 9, pp. 39-56

Pilkington, M. y Shamsipour, P. (2014). Noise Reduction Procedures For Gravity-Gradiometer Data. Geophysics. 79. G69-G78. https://doi.org/10.1190/Geo2014-0084.1.

Posloncec-Petric, V., Vuković, V., Franges, S., y Bacic, Z. (2016). Voluntary Noise Mapping For Smart City. Isprs Annals Of Photogrammetry, Remote Sensing And Spatial Information Sciences. Iii-4/W1. 131-137. https://doi.org/10.5194/Isprs-Annals-Iii-4-W1-131-2016.

Radun, Jenni; Maula, Henna; Saarinen, Pekka; Keränen, Jukka; Alakoivu, Reijo; y Hongisto, Valtteri. (2022). Health effects of wind turbine noise and road traffic noise on people living near wind turbines. Renewable and Sustainable Energy Reviews. Volume 157, 112040, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2021.112040.

Rodríguez - Manzo, Fausto E. (2015). Ruido ambiental, comunicación y normatividad en la Ciudad de México. Razón y Palabra, (91). https://www.redalyc.org/articulo.oa?id=199541387021

Rodríguez Manzo, Fausto E. y Juárez González, Leticia (2020). Exploración cualitativa sobre el ruido ambiental urbano en la Ciudad de México. Estudios demográficos y urbanos, vol. 35, núm. 3, 2, Septiembre-Diciembre, pp. 803-838. El Colegio de México. DOI: 10.24201/edu.v35i3.1934

Rodríguez-Manzo, Fausto Eduardo; Garay Vargas, Elisa; Lancón Rivera, Laura Angélica y Sánchez Ruiz, Gerardo Guadalupe. (2016). Ruido ambiental y políticas públicas. Un presente y hacia el futuro en Azcapotzalco Espacialidades. Revista de temas contemporáneos sobre lugares, política y cultura, vol. 6, núm. 1. pp. 72-103. https://www.redalyc.org/articulo.oa?id=419548242004

Torres-Sotolongo, D. E. y Romero - Suárez, P. (2014): "Procedimiento para la evaluación del ruido ambiental urbano en el municipio de Regla (Cuba) utilizando sistemas de información geográfica", GeoFocus (Informes y aplicaciones), no14, p 1-15. ISSN: 1578-5157

Unión Europea (2002). DIRECTIVA 2002/49/CE DEL PARLAMENTO EUROPEO Y DEL CONSEJO. Sobre Evaluación y Gestión del Ruido Ambiental. Diario Oficial de las Comunidades Europeas. núm. 189. https://www.boe.es/doue/2002/189/L00012-00025.pdf

Wawa, A. y Mulaku, C. (2015). Noise Pollution Mapping Using Gis In Nairobi, Kenya. Journal Of Geographic Information System, 07(05), 486–493. Https://Doi.Org/10.4236/Jgis.2015.75039

Zuo, J., Xia, H., Liu, S. y Qiao, Y. (2016). Mapping Urban Environmental Noise Using Smartphones. Sensors (Switzerland), 16(10). Https://Doi.Org/10.3390/S16101692