



Inter-comparison of noise pollution in Oran (Algeria) : Urban and industrial areas

I. Arbaoui¹, A. Hamou¹, H. Abderrahim^{1,2}, A. Tayeb^{1,3}, M. R. Chellali⁴

¹Laboratoire d'Etudes des Sciences de l'Environnement et des Matériaux, Département de Physique,
Faculté des Sciences Exactes et Appliquées, Université Oran1, Ahmed ben Bella Algérie .

²Institut Hydrométéorologique de Formation et de Recherche d'Oran, Algérie.

³Chef Département Hygiène, Sécurité et Environnement LRP Sonatrach, Algérie.

⁴Faculty of Materials Science and Technology, Slovak University of Technology in Bratislava,
Bratislava, Slovakia.

Received 14 Apr 2017,

Revised 17 Jul 2017,

Accepted 20 Jul 2017

Keywords

- ✓ Oran,
- ✓ noise,
- ✓ noise mapping,
- ✓ industrial unit,
- ✓ noise pollution,

arbaoui.iliace@gmail.com;

Phone: +213664086163;

Abstract

This study carried out aims to evaluate noise pollution in Oran province in Algeria (urban and industrial areas), and compares between noise pollution levels in both areas. Eventually, the noise is an integrated part in our environment; it makes actually a great challenge because of the dangerous health troubles it causes. Otherwise, a few studies were scientifically carried out on industrial noise in Algeria; but more and deeper researches are needed in order to determine its origins, sites measurements, noise mapping, and finally giving suggestions about the problem solving. Firstly, we've divided this work into two parts; the first was about the urban area in Oran province where the population is exposed to all noise types especially road traffic noise. The second part concerning the industrial area where a higher level of noise is observed, it skips the Algerian standard norms, and this noise pollution is mainly generated by machine engines. By a simple comparison between noise levels in both areas, we can observe that noise pollution is higher in the industrial areas than in the urban ones.

1. Introduction

Noise is one of the physical environmental factors affecting human health. Because of its adverse effects on people, life in the large and industrial cities is being more difficult [1]. Actually, more importance is given to environmental issues such as air pollution and noise pollution [2], the concern about noise pollution is acquiring considerable importance especially in industrial environments where there exist a lot of machinery and equipment [3]. Environmental noise pollution relates to noise caused by transportation [4], industry [5-6] construction workshops, as well as some other outdoor activities [7]. Noise pollution is considered to be the second among a series of environmental "stressors" for the public health effects [8]. Regular and long-term elevated noise exposure can bring various adverse health effects, such as hearing troubles, blood hypertension, heart disease, and sleep disturbance [9].

The effects of noise pollution exceed health problems, they also cause purchase problems, a recent study shows that road traffic noise has a considerable impact on purchasing decisions made by apartment buyers; this is not only a widespread problem in Africa, but in the Central-Eastern Europe as well [10]. Sources of noise are numerous but they may be broadly classified into two classes: industrial and nonindustrial. Industrial and transportation sectors are one of the most common sources of noise pollution [11].

The noise does not only affect life quality, but also the public health throughout certain noise levels. The Algerian executive decree 93-184 dated on July 27th, 1993 organizes noise emissions its second article says: "the maximum noise level in urban areas, industrial areas, public places and roads should be 70 dB at morning (6:00 am to 10:00 pm), and 45 dB at evening".

The Algerian industry is an essential segment of the economic development of the country. However, it affects our environment with a significant amount of pollution such as (the atmospheric pollution [12-15], solid [16-

18], water [19] and marine [20], etc). Among these types of pollution, noise pollution is poorly studied in Algerian scientific research. Actually, so many studies have been done on the world scale to treat the road traffic noise problem, [21-27], in addition to that, the growing number of noisy industrial units, and also the large unaccountable number of party rooms construction with no respect for the decree 93-184 which defines the official norms have lead the city of Oran to be so noisy. It's so important to mention that the law imposes some intense conditions on people who want to invest in noisy projects. The decree is not only limited to industrial enterprises ,but also insists on construction enterprises to respect acoustic norms and walls quality for buildings, moreover, these buildings should be built far away from traffic roads [28].

On the other hand, in the last years, several projects and workshops have been achieved under public authorities' supervision; some of these workshops' projects take a long time to be finished; a lot of projects are expected to be achieved in the province of Oran. The given data do not only need the decree 94-184 to be applied; but also to be adapted to the city of Oran's properties. To reduce the hardships and all the problems related to the process, a large campaign to heighten the population's awareness is required.

Certain extra-hearing manifestations can be observed, we are talking about "consequences that affect certain organs and functions». In a professional activity on people exposed to noise, the results have shown a remarkable rise of sleep time, and a growing blood pressure, etc. The consequences on health are various, they are more and less dangerous; both direct and indirect causes can be distinguished such as: jumpiness, insomnia, depression and hearing problems which may lead to temporal or definite deafness [29]. The executive decree 93-184 dated on July 27th,1993 seems not to be enough , and a new regulations need to be imposed .A noise mapping in the province of Oran according to the regional specifications should be drawn up by The Territory Arrangement, Environment, and Tourism Ministry. This suggested work has dealt firstly with noise pollution in the urban area in Oran province; it's based on measurements achieved in specific sites such as buildings, hospitals, schools, universities, public gardens...etc. These noise measurements were carried out in given hours and days, and their results are related to given places and sites in the province of Oran. Lastly we've moved to the second step about noise pollution in industrial areas, therefore, the industrial area of Arzew was chosen, it should be known that this area is classified among the first twenty industrial areas on the world in the field of hydrocarbons treatment and exploitation .

2. Material and Methods

2.1. Site selection

To get the final purpose of this work, which represents an inter-comparison of noise pollution in the province of Oran (both urban and industrial areas); two areas have been chosen to be examined:

2.1.1. The province of Oran's urban area:

Oran is an important coastal city that is located in the north-west of Algeria as shown in the figure 1. It is considered the second most important city after the capital Algiers, due to its commercial, industrial, and cultural importance. It is 432 km (268 mi) far from Algiers. The metropolitan area has a population of approximately 1,500,000 making it one of the largest cities in the country.

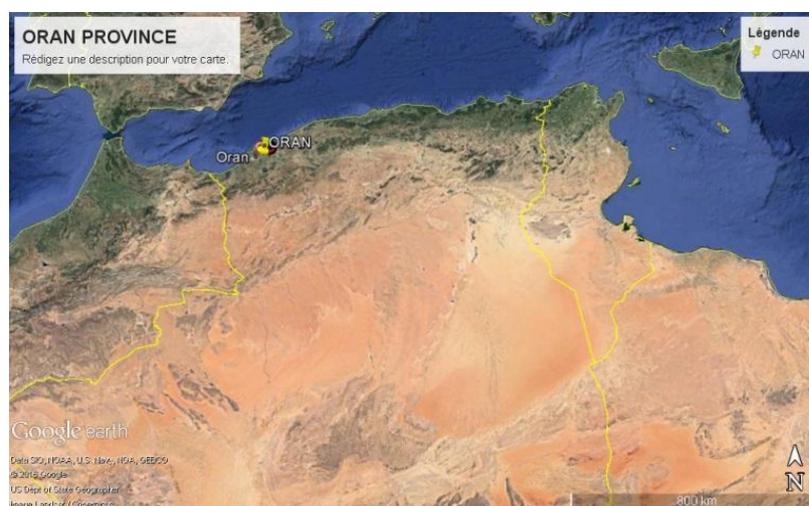


Figure 01: ORAN province geographical location

2.1.2. Industrial area:

The province of Oran contains a very large industrial area in the field of hydrocarbon exploitation and treatment called Arzew's industrial area. Figure 2 represents the geographical location of Arzew's industrial zone ; it's classified among the first twenty industrial areas in the world.



Figure 2: Arzew industrial zone's geographical location

The measurement norms we've used are in accordance with the norm NFS 31.010, the measurement intervals are about 30 minutes, except in case of a very stable noise. The measurement emplacements are not chosen aleatorily, but precisely, with taking in account the several parameters to get the real level of the noise measurements in both Oran's urban and industrial areas. e.g; in the urban area we chose : overcrossed areas, public places and intersections,etc. also in the industrial area we chose: the noisiest machines working on 24 hours with continuous mode system.

In order to measure the noise levels in the agglomerations, many experiments have been carried out. The materials and equipment which have been used are:

2.2. Material used:

The sound level meter we used is Roline RO-1350 type II. It includes a special amplifier; a microphone and a voltage divider which allow reaching an attenuation of electric signals, for stay in the amplifier linearity range (50 to 80 dB) whatever the sound level. The Attenuator function can also allow the display of an easy-to-read measurement. It also includes the weighted filter, in particular the weighting filter A (it's a detection and reading device), that contains another amplifier and rectifier. So that the signal displayed is proportional to the effective noise pressure.

2.3. Social survey:

The social survey was carried out simultaneously with urban noise measurements and at the same sites;08 sites have been chosen (inside buildings, campuses , crossroads, hospitals, primary schools, high schools ,universities and public gardens), each site is a source of noise, the chosen zones have a wide geographical distribution within the province of Oran's urban area, representing all urban noise levels from 55to 81.5 dB (A), to investigate individual attitudes and opinions in respect of different aspects of noise in Oran's urban area.

Questionnaires have been distributed, the questionnaires contained 8 questions oriented to primary school pupils, high school and university students, teachers and the city's inhabitants about demographic data, educational level, annoyance, psychological and physiological effects, reactions against urban noise, daily exposure times, the most sensible category, and the exposure to road traffic. The questionnaires were distributed by hand and the respondents completed the questionnaires themselves. A total of more than 190 questionnaires were distributed ,but only 170 questionnaires filled by people of different ages were finally collected.

3. Results and discussion

3.1. Noise pollution measurements in urban areas:

In the first part of our work we have carried out noise measurements in order to evaluate the noise pollution in urban areas; therefore, we have chosen different sites in the city of Oran such as crossroads, buildings, hospitals and public gardens.

Other measurements have been carried out in other neighborhoods in Oran city at the same scheduled times. These sites are Miramar, city center, M'dinaJdida, Médioni, Choupot, Sidi El Bachir, Saint Eugène, Hippodrome and Gambetta. Table 1 illustrates the chosen sites' astronomy coordinates and the obtained noise measurements. In the next step, we've chosen to represent these obtained results illustrated in the table 01 in histograms, in order to analyze, comment on and compare between the noise levels obtained in Oran's urban sites represented in fig.3.

Table 1: Noise level in urban area

	Date	Time of mesurment	GPS coordinates	Noise level dB(A)
City center (crossroads)	17-02-2016	8:00 am-12:00am	35°42'10.38"N/ 0°38'14.83"O	81.5
City center (building)	18-02-2016	8:00 am-12:00am	35°42'8.48"N/0°38'32.49"O	75
Miramare (crossroads)	19-02-2016	8:00 am-12:00am	35°42'20.66"N/ 0°38'18.02"O	75.5
University Hospital Center CHU 1 (inside Hospital)	20-02-2016	8:00 am-12:00am	35°41'42.18"N/0°38'32.47"O	61
University Hospital Center CHU 2 (outside Hospital)	21-02-2016	8:00 am-12:00am	35°41'39.00"N/0°38'26.44"O	64
Miramare (building)	22-02-2016	8:00 am-12:00am	35°42'11.00"N/ 0°38'44.11"O	64
M'dina Jdida (public gardents)	24-02-2016	8:00 am-12:00am	35°41'17.90"N/0°38'49.26"O	55
EHU 1 (inside Hospital)	27-02-2016	8:00 am-12:00am	35°41'49.07"N/ 0°34'58.69"O	59.5
EHU 2 (outside Hospital)	28-02-2016	8:00 am-12:00am	35°41'56.86"N/ 0°34'55.49"O	65
Es-Seddikia (building)	01-03-2016	8:00 am-12:00am	35°42'21.89"N/ 0°36'23.26"O	57
El Morchid (public gardents)	02-03-2016	8:00 am-12:00am	35°42'27.77"N/ 0°35'46.88"O	79
Choupot (building)	05-03-2016	8:00 am-12:00am	35°41'5.15"N/ 0°39'13.55"O	59
Choupot (crossroads)	06-03-2016	8:00 am-12:00am	35°40'58.65"N/ 0°39'20.34"O	74
Sid Elbachir (crossroads)	06-03-2016	8:00 am-12:00am	35°41'52.07"N/0°38'20.94"O	67
. Sid Elbachir (building)	07-03-2016	8:00 am-12:00am	35°41'51.46"N/0°38'38.50"O	60
Saint Eugene (crossroads)	10-03-2016	8:00 am-12:00am	35°41'49.09"N/ 0°36'49.56"O	75
Saint Eugene (public gardents)	11-03-2016	8:00 am-12:00am	35°41'44.79"N/ 0°37'9.71"O	62
Hippodrome (crossroads)	14-03-2016	8:00 am-12:00am	35°41'59.55"N/ 0°37'4.77"O	69
Hippodrome (building)	14-03-2016	8:00 am-12:00am	35°42'6.36"N/ 0°36'55.21"O	60
Gambetta (crossroads)	23-03-2016	8:00 am-12:00am	35°42'25.32"N/ 0°37'17.05"O	73
Gambetta (building)	23-03-2016	8:00 am-12:00am	35°42'29.98"N/ 0°37'8.84"O	62

This histogram indicate that the noise levels are higher in crossroads and CHU; they may attain the 80 dB (A), but, they could be bearable in buildings inside the city center.

The studies carried out in the urban towns give a clear vision about the noise pollution's sources; they are obviously different from one area to another. 46 % of noise comes from the road traffic (automobiles), the rest is generated by tramways, trains, neighbors, musical parties and workshops.

3.1.1 Results of social survey:

The respondents were both males and females their ages exhibit a wide range as 09% were less than 14 years, 22% were more than 31 years, 24% were 22–30 years, and 45% were 15–21 years (fig.4).we noticed that 83% of them were annoyed by urban noise pollution, this results is alarming.

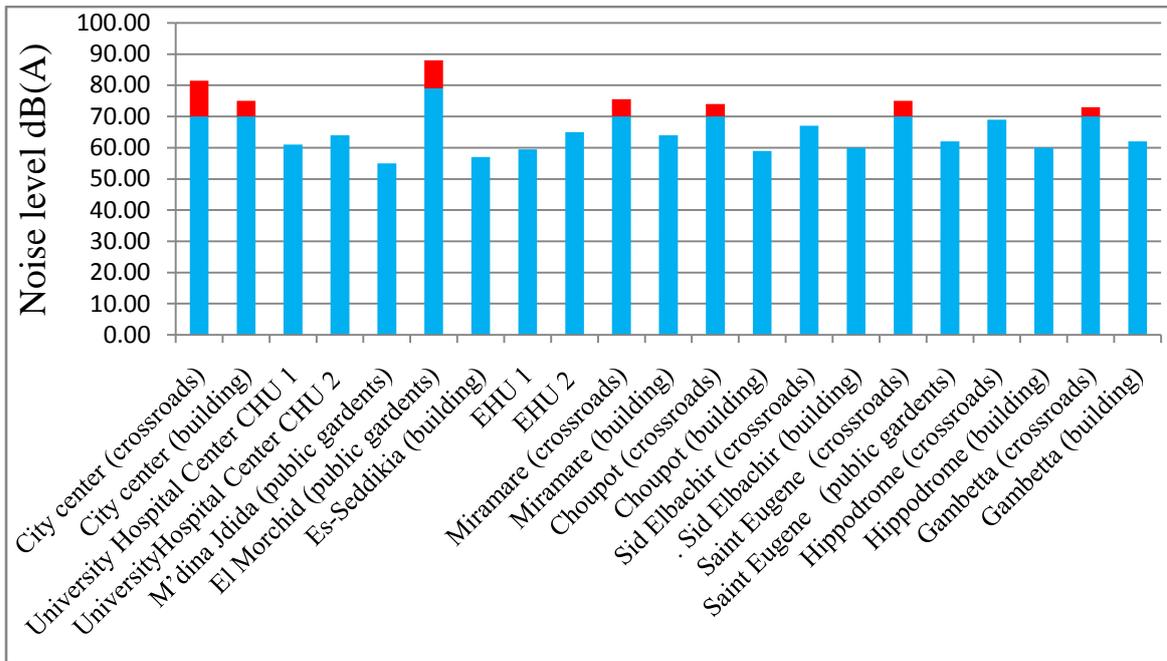


Figure 3: Histogram 1 of noise pollution in different sites inside Oran's urban area

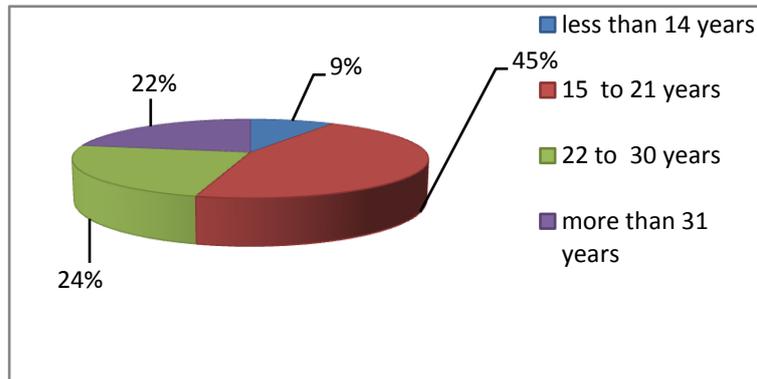


Figure 4: Age categories of respondents

It can be said that the noise pollution origins mentioned in the responses concern essentially road traffic, workshops and neighborhoods noise (fig.5), moreover 98% of the respondents declared themselves to be ‘‘highly annoyed’’ during the day, the given responses are similar at morning (16%), afternoon (42%), and at evening (40%) as it is illustrated in figure 6.

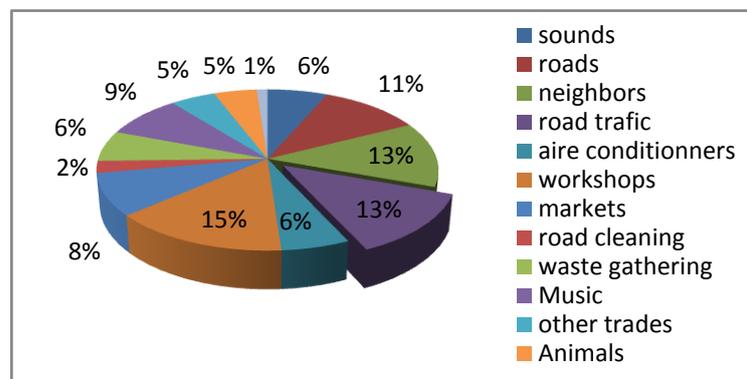


Figure 5: Noise pollution origins

From the results we have obtained, it's noticed that there was a strong relationship between noise origins and the period time when people are more exposed to noise, it means on the time of the day when workshops and road traffic activity is increasing it could be observed that more people are exposed to high level of noise in that particular period of time (fig.7). In terms of noise impact on people according to their age categories, the

responses are enough equivalent (fig.8). At the last step of the social survey concerns the consequences of noise on people's lives during all the days; 09% life conditions, 24% hearing, 32% mental health and 35% for all the other aspects of daily life (fig.9).

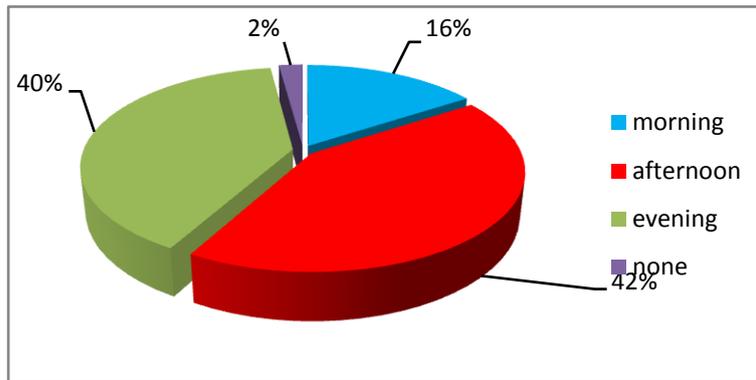


Figure 6: the day's moments of exposure to noise

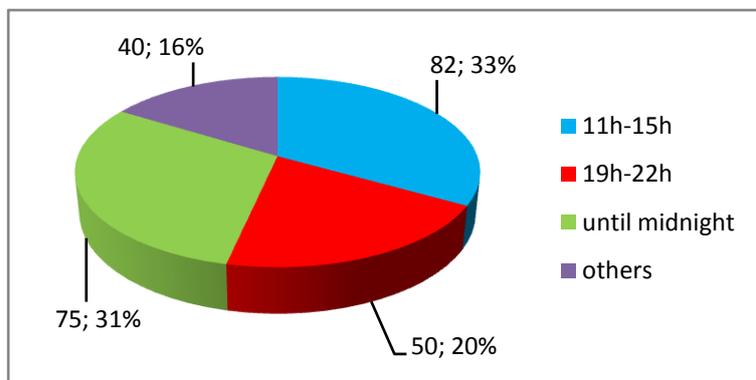


Figure 7: the day time of exposure to noise

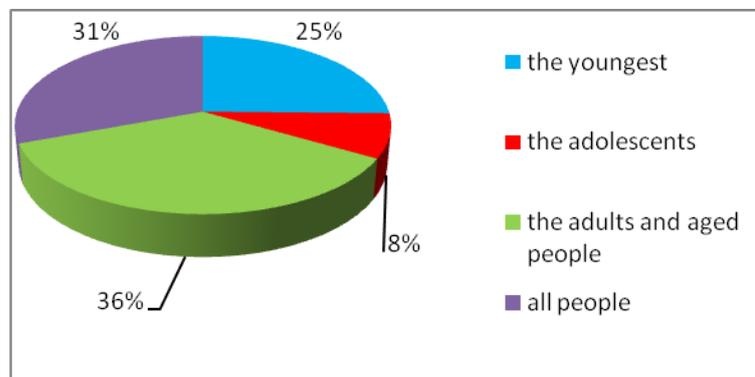


Figure 8: the population types exposed to noise

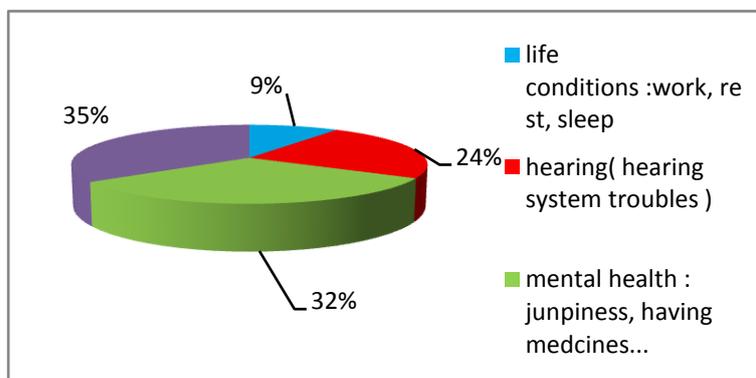


Figure 9: Noise consequences on life during all the days

3.2. Noise pollution in industrial areas in Oran province:

In the second part of this work we have evaluated noise pollution inside the industrial area, therefore, the industrial area of Arzew was chosen, and its 2223, 99 acres surface is reserved for petrochemical factories, among these factories, two of them have been chosen: GL1Z and GL2.

The figure 10 shows the location of the factories (GL1Z and GL2) that we have chosen in the industrial area of Arzew. The measured noise pollution results that we have obtained are listed in table 2:

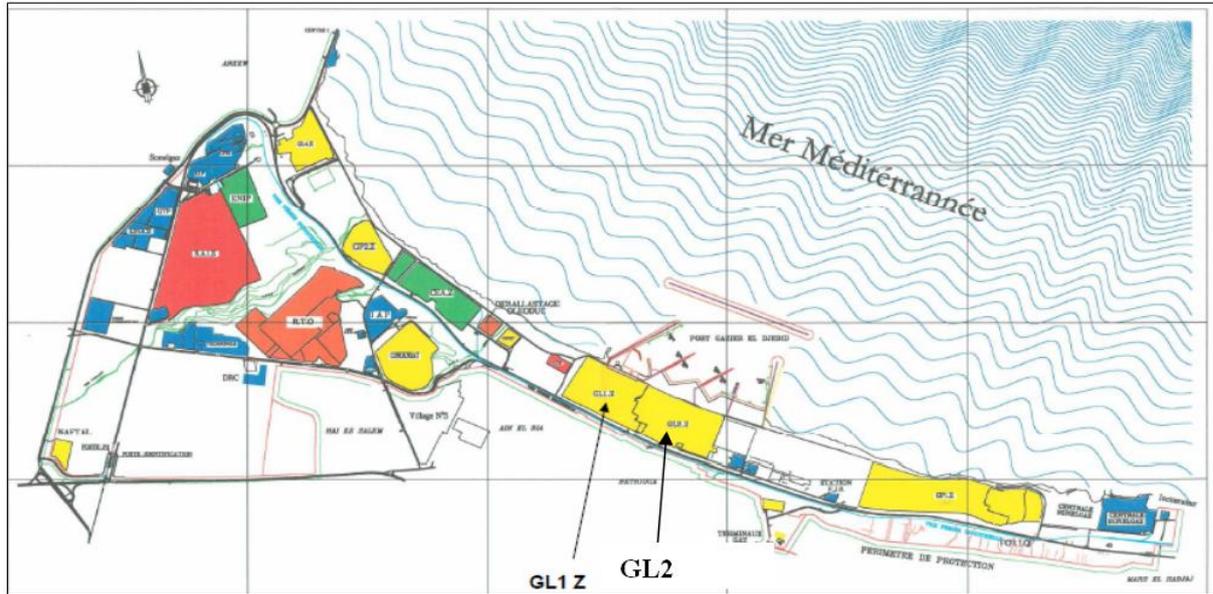


Figure 10: Mass plan of Arzew industrial zone

Table 2: Noise level in GL1Z and GL2Z factories

Measurements points	GL1 Z factory		GL2Z factory	
	Measurements areas	Noise level dB(A)	Measurements areas	Noise level (A)dB
Point 1	Train 100	95	Train 100	115
Point 2	Train 200	95	Train 200	95
Point 3	Train 300	95	Train 300	95
Point 4	Train 400	95	Train 400	95
Point 5	Train 500	95	Train 500	93
Point 6	Train 600	95	Train 600	95
Point 7	Boiler IHI et MHI	106	Boiler ABB	110

According to the results we've obtained and we have represented in figure 11, we can observe that the noise levels are so high inside the two factories; they skip the steps allowed by the Algerian regulations, all that is due to the following reasons:

- The most noisy machines in both factories are turbines and compressors because they are feed by a huge fluid flow
- the major part of the machine are old machines, thus, the machine age represents an important factor in the noise pollution generation.
- Certain noise pollution generating machines need to be maintained because of the high noise they generate
- Lack of noise reduction tools.

These gained results visualize that noise pollution in the industrial area affects directly the workers' health, and it affects also indirectly the neighboring inhabitant's health.

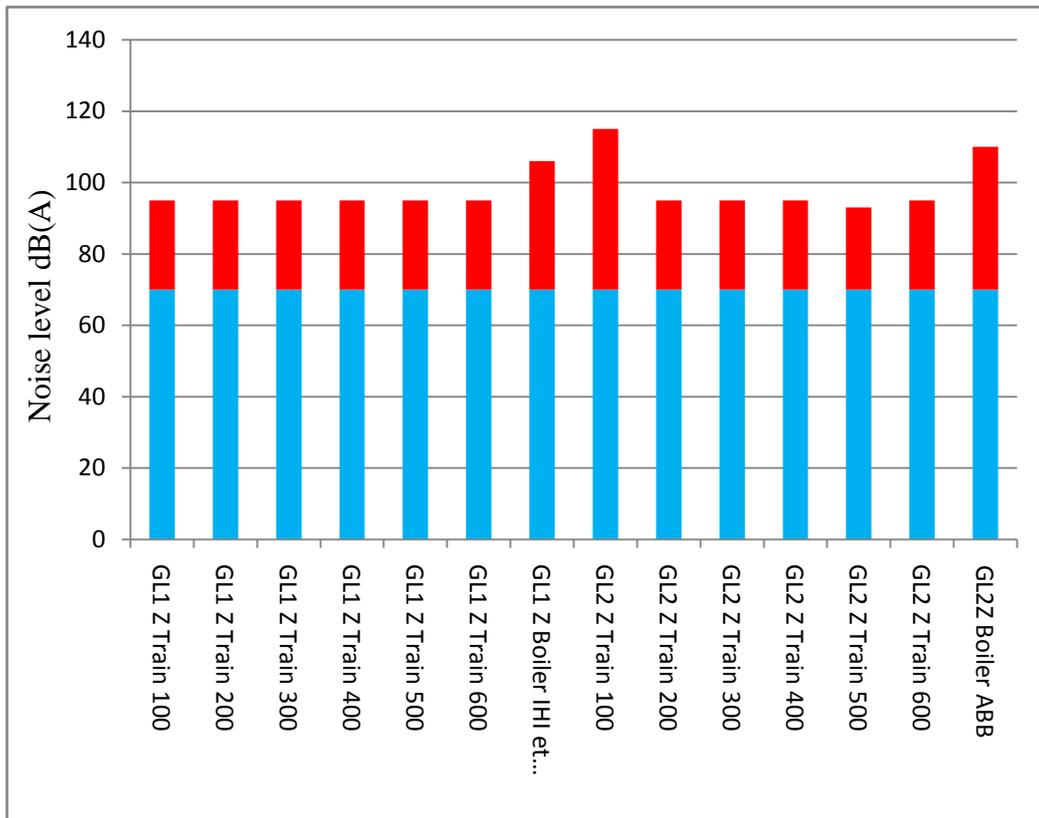


Figure 11: Histograms of noise level recorded in GNL1 and factories

The industrial noise problem is a complicated problem that requires deep studies, precise statistics, and noise mapping to identify the noisiest areas, and make a general bill, a simulator called COD-TYMPAN is used as a tool to create a noise mapping for the two factories (GL1Z and GL2Z)

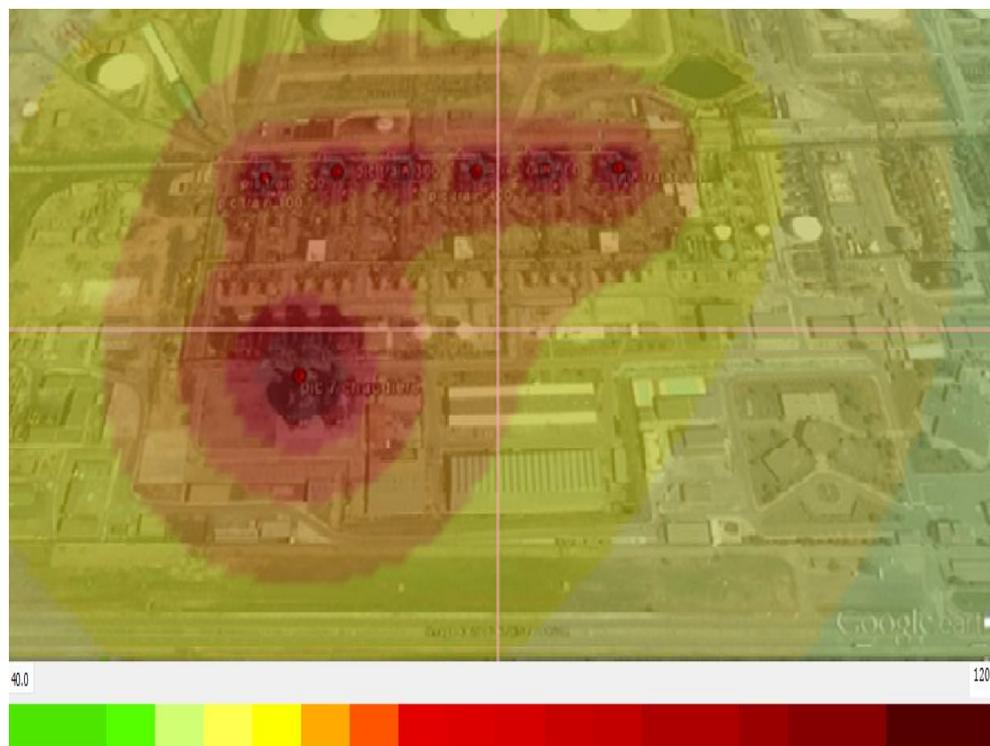


Figure 12: GL1Z noise mapping

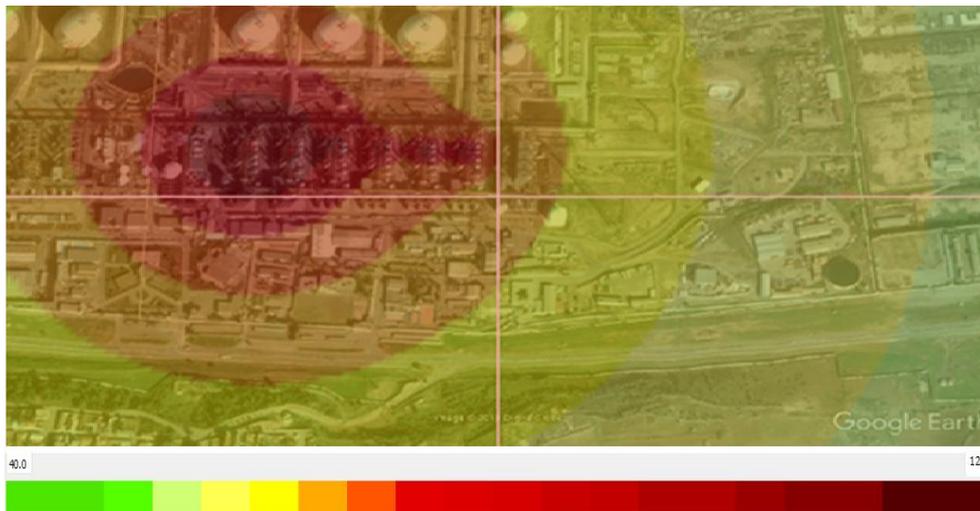


Figure 13: GL2Z noise mapping

The two Figures above (12 and 13) represent noise mapping in the two factories GL1Z and GL2Z; it's remarkable that the places where the turbines and the compressors installed are the noisiest places; but as far as we get away from the center of the noisy space, the noise gradually slows down.

Conclusion

In this study, an inter-comparison of noise pollution in Oran's province urban and industrial areas has been done; we've concluded that noise pollution is higher in the industrial area than in the urban area.

The results of the social survey show that 70% of respondents face urban noise levels ranged from 55 to 81.5 dB (A).

- ✓ 83% of respondents were highly annoyed by urban noise.
- ✓ 98% of the respondents were highly annoyed during the day.
- ✓ Road traffic, workshops and neighborhoods are the main origins of noise pollution in Oran's urban area.
- ✓ There was a strong relationship between urban noise origins and the period time when people are more exposed to urban noise.
- ✓ 24% of respondents are suffering from hearing troubles and 32% are exposed to mental health troubles.

On the other hand, the principal factors that cause noise pollution in the industrial area are rotor machines such as compressors, pumps and turbines, Results of industrial noise levels showed that noise levels were ranged from 95 to 115 dB (A).

Finally, we've made noise mapping of the two factories GL1Z.GL2Z to determine the noisiest areas from those which are less noisy.

References

1. A. Orkomi, B. Tavakoli, A. Noorpoor, *J. Occu. Health.Epidemio.* 2 (2013) 44-53.
2. D. Parmar, P. Dabhi, P. Soni, F.H. Pathan, *I. J. Adva. Research. Eng. Tech.* 4 (2017) 50-52.
3. J.O. Osarenwindi, A.A. Onojoserio, *J. Eng. Res. Applications.* 5 (2015) 1-5.
4. K. JoonHee, S.I. Chang, M. Kim, J. Seong, *Enviro. Inter.* 37 (2010) 328-34.
5. T.S. Bozkurt, S.Y. Demirkale, *J. Build. Eng.* 9 (2017) 60-75.
6. M. Aliabadi, R. Golmohammadi, H. Khotanlou, A. Salarpour, *Appl. Arti. Intelligence.* 29 (2015) 766-785.
7. A. Ongel, F. Sezgin, *Environ. Impa. Assessment. Review.* 56 (2016) 180-187.
8. A. Ruggiero, *Environ. Pollut. Climate. Change.* 1(2017) 1-2
9. Q. Li, F. Qiao, Lei Yu, *Environ. Pollut. Climate. Change.* 1 (2016) 1.
10. A. Szczepańska, A. Senetra, M. Wasilewicz-Pszczółkowska, *Trans. Res. Part D: Transp. Enviro.* 36 (2015) 167-177.
11. I.V. Murali, V. Manickam, *Enviro. Manag. Sci. Eng. Indus.* (2017) 399-429
12. A. Hamza, A. Hamou, *J. Mater. Environ. Sci.* 5 (3) (2014) 865-872.

13. A. Tayeb, A. Hamou, S. Debbah, *Jsm. Enviro. Sci. Ecol.* 3(1) (2015). 1015
14. A. Tayeb, A. Hamou, S. Debbah, *Jsm. Enviro. Sci. Ecol.* 3(2) (2015) 1021.
15. H. Abderrahim, R. Chellali, A. Hamou, *Envir. Sci. Pollut. Res.* 23 (2015) 1634–1641.
16. N. Ramdani, Y. Al-Douri, A. Hamou, *J. Mater. Environ. Sci.* 6 (5) (2015) 1310-1320.
17. N. Ramdani, A. Hamou, A. Lousdad, Y. Al-Douri, *Enviro. Tech.* 36 (2015) 1594–1604.
18. N. Ramdani, A. Hamou, S. Nemnich, A. Tilmatine, M. Boufadi, M. Llorénpascual del Riquelme, *J. Ecol. Health. Environ.* 3(2015) 81-90.
19. S. Boulaaras, K. Mahdi, H. Abderrahim, A. Hamou, S. Kabli, *Appl. Math.* 4 (2013) 456-463.
20. A. Tayeb, M.R. Chellali, A. Hamou, S. Debbah, *Marin. Pollut. Bull.* 98 (2015) 281–288.
21. T. Thevenin, *Doct. Dissert. Univ. Franche. Conté.* (2002) pp.8-31.
22. M. Mathieu Carrier, P. Apparicio, M. Séguin, *Canadian. Geographer.* 60 (2016) 394-405.
23. A. Bocquier, S. Cortaredona, C. Boutin, A. David, A. Bigot, V. Sciortino, S. Nauleau, J. Gaudart, R. Giorgi, P. Verger, *Euro. J. Public. Health.* 24 (2012) 298-303.
24. W. Babisch, D. Houthuijs, G. Pershagen, L. Jarup, *J. Acou. Society .America.* 123 (2008) 3448.
25. K. Yamamoto, *Acou. Sci. Tech.* 31 (2010) 2-55.
26. T. Sato, T. Yano, T. Yamashita, K. Kawal, *J. Arch. Planning.* 64 (1999) 17-23.
27. T. Chang, C. Liu, B. Bao, Y. Yen-Ju Lin, *Sci. Total. Environ.* 409 (2011) 1053-7.
28. F.Z. Younsi, *Commun. Science. Tech.* 8 (2010) 2-4.
29. S.A. Stansfeld, B. Berglund, C. Clark, I. Lopez-Barrio, P. Fischer, E. Ohrstrom, *Lancet.* 365 (2005) 1942 – 1949.

(2018) ; <http://www.jmaterenvirosci.com>