International Journal of Environmental Sciences Vol. 3 No. 4. 2014. Pp. 175-182

Full Length Research Paper

Spatial Variation of Noise Pollution Level in the Main Commercial Center in Addis Ababa, Ethiopia

[1]Andualem Mekonnen* and [2]Seyoum Leta**
[1,2] Center for Environmental Science, College of Natural Science, Addis Ababa University, Addis Ababa University, P.O. Box 33348, Addis Ababa, Ethiopia

**Corresponding Author: Andualem Mekonnen*

Abstract
This study was conducted to generate baseline information on the noise pollution level in Merkato open market in Addis Ababa. The level of noise was measured at 20 selected locations close to road side, road junction, worship areas, recycling and workshop areas. At each location, the noise level was measured in the morning, midday and afternoon period of the day. The recorded noise data was computed for Leq, Lmax, Lmin, L_{90}, L_{10} and L_{00}. In addition, using the daytime average noise level, cluster analysis and principal component analysis was performed. The results of the study showed that average noise was in the range of 61.7 to 83.9 dB (A) in all the measuring periods. The maximum value observed was in the range of 72.6 to 102.6dB (A) while the minimum value was in range of 46.7 to 71.9dB (A). The background noise computed was in the range of 57.5 to 75dB (A) in all the sites. On the other hand, the L_{90} was in the range of 66.1 to 95.3dB (A) and this is a noise due to intermittence source. The result of the measurement reveals that noise level at 19 of 20 locations exceeded the recommended limit 65 dB (A). This status of the noise level in the commercial center may pose a severe health problem after prolonged daily exposure. In addition, it may cause discomfort, annoyance and irritation and this in turn can drastically reduce productivity in the workers.

Keywords: *Addis Ababa,Background noise, Equivalent noise, Merkato, Noise level*

Introduction

Noise has been defined as an unwanted or harmful sound created by human activities. This includes noise emitted from workplace, means of transport, commercial and industrial activities (Anomohanran *et al.,* 2008). Noise pollution doubles every year along with the progress of society and industry. In urban areas, the problem of noise pollution is ranked to be third next to air and water pollution (Gaganija *et al.,* 2012). A lot of research finding showed that noise pollution may cause an adverse impact on human health that range from annoyance to insanity and death (Mato and Mufuruki, 1999). It is believed that noise exposure with a level of 80db (A) for 8 hours per day damage hearing (Nelson, 1987). In addition, high level of noise causes sleep disturbance (Hume *et al.,* 2012), interfere with speech comprehensions (Tamoczy, 1983), hypertension and heart diseases (Goines and Hagler, 2007). In the developed world, a lot of actions have been taken to minimize the problems resulted from noise pollution. These actions include noise pollution control legislation/act, regulations and noise policies (Hamed *et al*., 2008; Hai *et al.,* 2009. In the developing world, the problem is not equally recognized by all countries. In some countries, studies have been carried out to assess noise pollution status (Anomohanran *et al.,* 2008; Hamed *et al*., 2008; Ali and Tamura, 2003; Onuu, 2000). Even countries like Egypt introduced restrictions to improve environmental conditions. This restriction include (i) ban on horns, (ii) ban on horns and trucks, (iii) ban on horns, trucks and noisy buses (Ghatass, 2009). On the other hand, other countries including Ethiopia have not yet fully recognized noise pollution as human health risk factors. This could be due to lack of baseline information on the level of noise in industrial, commercial and residential areas of the urban setting as well as its effect on human health. However, noise pollution in Addis Ababa has shown significant change from time to time as evidenced by the increasing number of complaints (Aberra Birhanu, 2011). This is due to the change in industrialization, urbanization, population growth, expansion of road network and increase in the number of motor vehicles over the last 10 years. Moreover, noise pollution around commercial center could be significant, because of improper planning and construction of buildings. Hence, there should be legal framework to manage noise pollution in commercial center and other urban areas. However, the development and implementation of legislative measures should be based on scientific information. Baseline information on the status of noise pollution level in the commercial areas should be generated to support control measures in this

specific setting. This research aimed to assess and generate baseline information on the status of noise pollution in Merkato open market in Addis Ababa, Ethiopia.

Materials and Methods

Study area

This study was conducted in the largest open market which known as "Merkato" in the city of Addis Ababa, Ethiopia. Merkato covers 10 square miles (Helgerson, 2012). It is organized into zones that specialize in groups of good such as metalwork, plastics, or electronics, etc... In Merkato, over 13,000 employees are working for 7,100 business entities including some 2,500 retail shops and open stalls. The market is home to upwards of 200 vendors including blacksmiths, potters, carpenters and weavers. It is also home to 1500 service businesses and 80 wholesale operations in a dense sector of narrow streets and alleyways (Veser, 2005). In each day, around 500,000 people pass through the market and from these 200,000 people are living and working in the district (Helgerson, 2012). In addition, the market serves as place of residence, social encounter and religious worship.

Sound level measurement

The measurements were made around religious institutes; at the sides of the street; at road junctions; at market center inside recycling and workshop areas; market center without streets for vehicles and workshop machines at total of twenty sites, shown in Table 1. The instrument was held comfortably in hand with the microphone pointed at noise source at a distance not less than 1m away from any reflecting object. *L*Ai (A-weighted instantaneous sound pressure level) measurements were recorded for a period of 12 min on the 'Fast' range Time Weighting. This was made five times per day at each sampling location. This was carried out in the morning (7:45–3:00 a.m and 3:35-.5:00), noon (12:00am–1:15p.m.), in the afternoon (2:00-3:15pm and 4:00–5:15 p.m.).

Table 1. Location selected for noise level measurements in Merkato commercial center

Designation No.	Location	Designation No.	Location
1	Alem Electronics	11	Kokebe Café
2	Unit Electronics	12	Ameda shoes Gebeya
3	Nile Insurance	13	Bermel Tera
4	Raguel Church	14	Tawela tera
5	Tana Gebeya	15	Bomb Tera
6	Saten Tera	16	Dir Tera
7	Arategna	17	Gesho Tera
8	Ameda Gebeya 2	18	Mearab Hotel
9	Kagnew Hotel	19	Zingibel Tera
10	Traditional Souvenirs	20	Minalesh Tera

Noise Indicators

The level of noise pollution was evaluated using L_{Aeq}, L_D, L_{10}, L_{90}, L_{max} and $L_{min,}$. L_{Aeq} is the A-weighted equivalent continuous level over the time period of the measurement, L_D is the daytime average sound level, L_{10} and L_{90} are percentile levels with the values exceed 10% and 90% of the elapsed time respectively, and Lmax and Lmin stand for the maximum and minimum sound levels detected

L_D are defined as the following

$$L_{D=}10log_{10}\left[\frac{1}{3}\left(antilog\frac{LAeq\ morning}{10}+antilog\frac{LAeq\ midday}{10}\ +\ antilog\frac{LAeq\ afternoon}{10}\right)\right]$$

Data analysis

The data was analyzed using Microsoft Excel and R statistical software. One way analysis of variance (ANOVA) was used to test the variation of noise level due to variation of measuring time and site. The significance difference between measuring time and between measuring sites were tested using Tukey post-hoc test or t-test at 95% confidence interval ($p<0.05$). Normalized data was used for cluster analysis. The following formula was used to normalized the data

$$Xi=\frac{Ll-Lmin}{Lmax-Lmin}$$

Results and Discussion

Noise pollution level close to the worship areas

The results of noise level measured at four locations close to worship areas are presented in Table 2. The equivalent average noise level recorded was in the range of 61.7 to 77.7dB (A). The minimum noise level observed at Alem electronics during the morning time of the day. This low noise level could be due to less movement and interaction of people in the morning time. On the other hand, the maximum average noise level was recorded at Unity electronic. This measuring site is closed to Anwar Mosque and the high noise level at this location could be due to the use of loud speakers for praying.

Table 2. Noise level in market close to worship areas

Site	Period of the day	Noise level descriptors (db(A))					
		L_{max}	L_{min}	L_{eq}± SD	L_{10}	L_{90}	L_{99}
Alem Electronics[1]	Morning	72.6	54.4	61.7±3.2	66.1	58.1	55.4
	Midday	80.2	59.3	67.9±3.9	73.6	63.4	60.2
	Afternoon	80.7	59.9	66.8±3.4	71.3	62.9	60.9
Unity electronic[2]	Morning	85.7	61.8	77.7±5.6	82.7	67.8	64.3
	Midday	89.7	62	71.5±6.9	84.3	64.8	62.9
	Afternoon	88.5	61.1	73.8±6.9	83.7	65.4	62.7
Nile Insurance[3]	Morning	96.1	57.6	65.9±4.2	71.2	61.2	59.3
	Midday	84.7	61.6	68.9±3.6	73.6	64.5	62.8
	Afternoon	87.4	58.6	70.6±4.6	77.6	65.6	62.4
Addis Ababa Gebeya[4]	Morning	80.3	61.3	68.8±2.9	71.8	66.2	63.8
	Midday	81.9	63.7	72.7±3.2	76.5	68	65
	Afternoon	84.1	62.1	72.7±3.5	77.2	68.2	64.7

1=close to electronic shop, 2=close to Mosque, 3=in between church and Mosque, 4=close to spiritual song shop and church

The computed daily average noise level and pollution level were in the range of 66.2 to 75.1dB (A) and 69.7 to 92.6dB (A), respectively. The mean noise level observed in all locations at different periods of the day was higher than the permissible limit set for commercial area. The higher noise level observed in this location could be attributed to the use of speakers during praying in the church, the mosque and spiritual song shops. Noise from traffic and commercial activities were also additional sources. The analysis of variance test indicated that there is variation of noise level with variation of measuring period of the day in most of the sites ($p<0.05$). However, in the noise level measured closed to Tana Insurance, there is no significance noise level difference observed between the morning and midday ($p=0.34$) as well as midday and afternoon ($p=0.15$).

Noise pollution close to road side and road junctions

Table 3 shows the noise level recorded in the commercial shops close to roads sides and junctions. The average noise level was in the range of 67.6 to 74.2dB (A) and 61.2 to 71.3dB (A) for the sites close to road junctions and sides, respectively. The daytime average noise level close to the road junction and side were in the range of 69.2 to 71.4dB (A) and 61.2 to 71.5dB (A), respectively. In all the periods of the day, the mean noise level measured was above the permissible noise limits for the commercial sites.

Table 3. Noise level in the market area close to road junction and road side

Site	Period of the day	Noise level descriptors (dB(A))					
		L_{max}	L_{min}	L_{eq}	L_{10}	L_{90}	L99
Tana Gebeya[1]	Morning	86.1	58.7	69.5±4.5	74.9	64.1	61.5
	Midday	83.3	60.8	68.9±3.5	73.5	64.6	62.2
	Afternoon	85.2	62.3	71.0±3.5	75.6	66.8	64
Kagnew Hotel[1]	Morning	90.1	60	68.4±4.2	73.2	63.2	61.2
	Midday	85.3	65.2	70.9±2.99	74.9	67.2	66.0
	Afternoon	88.1	62.7	71.3±3.2	75.1	66.9	64.7

Bomb Tera[1]	Morning	86.9	58.4	68.2±3.9	73.3	63.7	60.9
	Midday	99.6	64.5	74.2±4.2	80.4	69.4	65.8
	Afternoon	89.1	66.3	71.7±2.9	75.3	68.3	66.9
Dir Tera[1]	Morning	84.3	59.2	67.6±3.8	71.6	63.9	61
	Midday	84	65.6	70.8±2.9	75.1	67.7	66.3
	Afternoon	84.2	62.5	69.3±3.4	73.5	65.3	63.6
Mearab Hotel[1]	Morning	82.1	59.9	67.8±2.9	71.5	64.4	62.4
	Midday	80.2	60.6	69.1±3.3	73.8	65	62.5
	Afternoon	84.5	61.7	70.6±3.8	75.7	65.8	63.2
Arategna[2]	Morning	82	54.3	63.4±4.6	69.2	57.5	55.2
	Midday	78	56.3	65.5±4.2	71.4	60.3	57.9
	Afternoon	81.5	55.7	66.6±4.2	72	61.2	57.9
Traditional Souvenirs[2]	Morning	80	59.5	67±3.6	71.9	62.4	60.5
	Midday	87.6	63.4	71.3±4.3	77.3	66.5	64.4
	Afternoon	84.6	60.3	68±3.5	72.6	63.9	61.9
Ameda cloth Shopping[2]	Morning	90.6	55.2	64.1±4.1	69.1	59.1	56.8
	Midday	77.1	56.5	64.2±3.8	69.7	59.8	57.6
	Afternoon	84.4	57.2	65.8±4.4	70.6	61.3	58.5
Kokebe Café[2]	Morning	88.8	63.2	69.8±3.0	73	65.6	63.8
	Midday	83.4	62.6	69.3±3.5	73.9	65.2	63.5
	Afternoon	82.5	64.2	69.4±2.4	72.6	66.9	65.3

1=market areas close to road junction and 2=market areas close to road side

In the areas closes to road junction, the mean noise level of the day in all the measuring periods was higher than the prescribed noise level for commercial area. This high noise level might be due to high traffic volume and slow speed close to the road junction. Noise from vehicle horns and engines are the major sources. There was also supplementary noise from the people moving and crossing the roads at the junction. There is significance noise level difference with variation in measuring period of the day ($p<0.05$). In comparing the noise level between measuring period at each location, there is no significance noise level difference at Tana Gebeya in the mid-day and afternoon period of the measuring day($p=0.22$).

In most of market areas closed to the road side, the daytime average noise level exceeds the maximum permissible limit set for commercial areas. The noise level measured at Ameda was within the permissible limit. This could be due to low traffic volume in the nearest road. Like the areas closed to the road junction, there is significance noise level difference among sites closed to road side with variation in measuring periods ($p<0.05$). In comparing the noise level between measuring periods, there is no significance noise level difference between midday and afternoon time ($p=0.62$) at Kokebe café and in the morning and midday at Ameda ($p=0.62$).

Noise level in the market area without traffic and workshop

In the open market, there are areas that are far away from traffic, workshop and religious institutes. The noise level measured in four different selected locations of these areas is presented in Table 4. The average noise level recorded at different periods of the day was in the range of 64.0 to 71.2 dB (A) and daytime average noise was in the range of 65.7 to 69.5 dB (A). The lowest noise level was measured at Ameda shoes shopping center. The average noise level computed for the morning, midday and daytime was within the permissible limits for commercial center.

Table 4. Noise level in Market area far from Traffic and workshop

Site	Period of the day	Noise level descriptors (dB(A))					
		L_{max}	L_{min}	L_{eq}	L_{10}	L_{90}	L_{99}
Ameda shoes Gebeya	Morning	78.4	55.2	67.8±3.4	72.2	63.8	61.2
	Midday	74.9	55.6	64.3±2.9	68.1	61.3	56.2
	Afternoon	79.9	55.3	64.0±3.7	68.9	59.7	56.9
Gesho Tera	Morning	83.9	57.4	68.0±4.2	73.8	63.4	60.2
	Midday	88	61.1	69.6±4.4	75.7	64.5	62.0
	Afternoon	86.3	63.7	70.3±3.4	74.5	66.4	64.4
Zingibel Tera	Morning	84.1	58.4	67.4±3.9	72.6	62.9	60.6
	Midday	83.7	60.7	69.1±3.4	73.7	64.9	62.5
	Afternoon	83.4	62.5	71.2±2.9	74.9	67.9	64.5
Saten Tera	Morning	82.7	60.2	66.1±3.6	70.7	62.2	60.7
	Midday	81.2	60.6	66.9±3.5	71.8	62.8	61.2
	Afternoon	79.5	60.3	67.2±3.3	71.8	63.5	61.6

On the other hand, the noise level recorded in all the other locations was higher than the permissible national noise standard. Noise from radio speaker and people interaction and movement were the major sources of noise. In all the four location, there is significance variation of noise level with variation in measuring period of the day ($p<0.05$). In addition, there is a significance difference ($p<0.05$) in noise level recorded between different periods of the day at each measuring location.

Noise close to recycling and workshop areas

Table 5 presents noise descriptors measured at metal recycling (Bermel Tera and Minalesh Tera) and wood workshop (Tewela Tera) in the open market. The noise level observed at different periods of the day was in the range of 73.9 to 83.9dB (A) in the metal recycling areas and 71.3 to 78.1dB (A) in the wood workshop area. The maximum noise level recorded were 88.3dB (A) and 102.6 dB(A) for wood workshop and metal recycling areas, respectively.

Table 5. Noise level at the commercial center inside recycling and workshop areas

Site	Period of the day	Noise level descriptors (dB(A))					
		L_{max}	L_{min}	L_{eq}	L_{10}	L_{90}	L_{99}
Tawela tera[1]	Morning	85.4	61.5	71.3±3.6	75.8	66.5	63.7
	Midday	85.4	69.2	78.1±2.5	81.8	75	73.1
	Afternoon	88.3	71.9	75.0±3.1	78.3	71	68.2
Bermel Tera[2]	Morning	93.6	46.7	76.7±4.9	83.1	70.9	67.5
	Midday	91.7	66.8	81.2±4.4	85.	74.2	68.4
	Afternoon	87.2	62	73.9±4.0	79.2	68.8	64.9
Minalesh Tera[3]	Morning	102.6	49.6	83.4±8.3	95.3	73.9	67.3
	Midday	100.4	58.9	83.9±7.6	93.3	73.3	63.1
	Afternoon	102.4	64.2	83.8±7.2	93.8	73.6	67.6

1=close to wood workshop, 2=close to metal sheet recycling and 3=close to all sort of metal recycling

The average noise level recorded for different measuring periods and daytime (L_D) were above 65dB which is the permissible standard. Noise from hammering of metal bar and metal sheets were the major sources of noise in metal recycling area and noise from workshop machineries were sources of noise in wood workshops. The noise level measured shows significance difference with

variation in measuring period ($p<0.05$). In Minalesh metal recycling, the noise level measured in the midday and afternoon was not significantly different ($p=0.62$).

Mean noise

As shown in Figure 1, the mean noise level computed for the morning time was above the permissible limits at three locations (Alem, Arategna and Ameda). In all the remaining location the noise level was above the limits. In comparison with the mean noise level of the midday and afternoon, the mean noise level in the morning time was lowest in most of the sites. The mean noise in the miday at Amede cloth shopping center and afternoon at Ameda shoes center was within the permissible limits. The daytime mean noise level was higher in all the location except Arategna. In observing the trend of mean noise, the higher noise level was observed in midday and afternoon time.

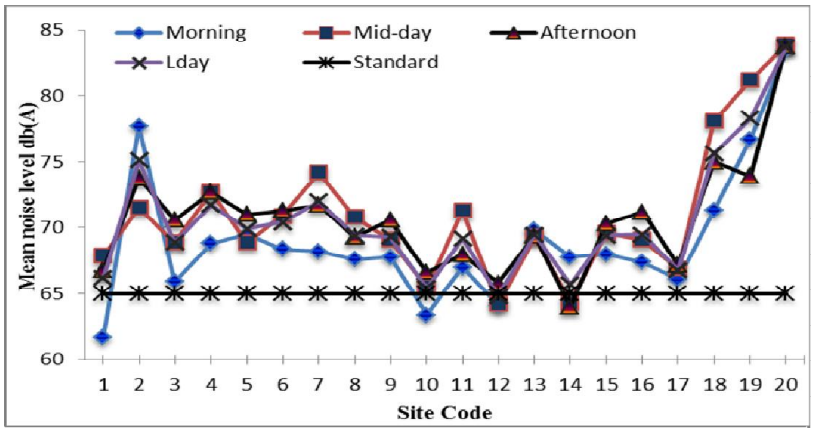

Figure1. The daytime and measuring period average noise level in db(A)

L_{10} and L_{90}

Figure 2 shows the statistical Levels L_{10} and L_{90} in all the measuring sites. L_{10} was observed to vary in the range between 66.1 to 95.3 dB (A). In all the measuring period, the highest L_{10} was recorded at the recycling and workshop areas. At Minalesh recycling, in ten percent of the measuring time the noise level was in range of 93.3 to 95.3 dB (A). The Lowest range (66.1 to 71.3dB (A)) was observed at Alem. In comparison with the other measuring period, the lowest peak noise (L_{10}) value was recorded in the morning period.

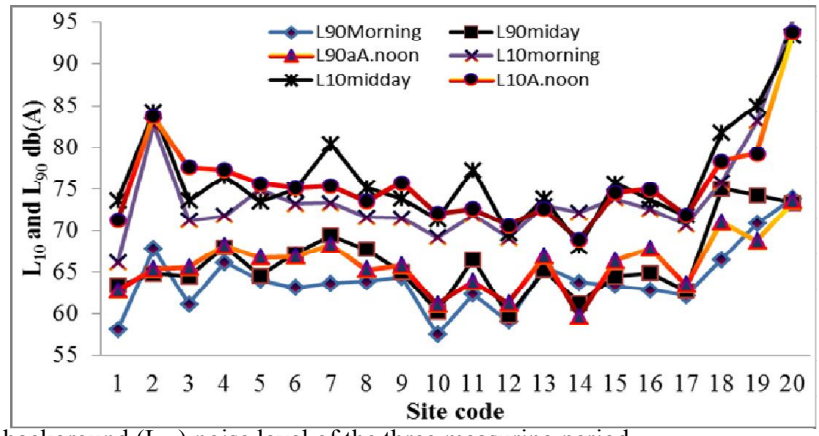

Figure2. The peak (L_{10}) and background (L_{90}) noise level of the three measuring period

The background noise (L_{90}) was recorded in the range of 55.4 to 73.1dB (A). The highest background noise level was recorded in the recycling and wood workshop areas. In these area, the L_{90} was in the range of 63.1 to 73.1dB (A) in all the measuring period. In most of the measuring sites the background noise was lower in the morning time than the rest time.

Multivariate analysis of noise pollution

Similarity of sites in noise pollution

Figure 3 shows the result of the cluster analysis. All the 20 measuring sites in the open market were classified into four clusters. Cluster 1contains only site 20 and similarly, cluster 2 consists site 19. These two clusters are the most polluted of all the other groups and they are representing metal recycling area. The noise level at site 20 is more significantly different from the noise level measured in at all the other location ($p<0.05$). The noise level at site 19 is not significant with site 18 and it is highly significant with all the remaining sites. Cluster 3 consists of all the sites coded from number 3 to number 17 and site 1. In this cluster, some of the sites have statistically similar noise pollution level. For example, the noise level measured at site 8 was not statistically different from site 3, site 4, site 5, site 11, site13, site15 and site 16 ($p=1.00$). Similarly, the noise level at site 15 was not different from site 3, 5, 9, 11and 16 ($p=1.00$). The noise at site 5 was also similar with site 6, 13 and 16 ($p=1.00$) and site 13 had also similar noise level with site 6, 9, 11 and 16 ($p=1.00$). In addition, the noise at site 11 was similar with site 3, 6 and16. The other sites which have similar noise levels are site 1, 10 and 14 ($p=1.00$). The noise level in all these three sites are significantly different from any of the other sites within the cluster except site 16 ($p<0.05$). However, the nose level measured in most of all the other sites are not statistically different from one another ($p>0.05$). Cluster 4 is the last cluster which contains site 2 and site 18 which have statistically similar noise level ($p=1.00$).

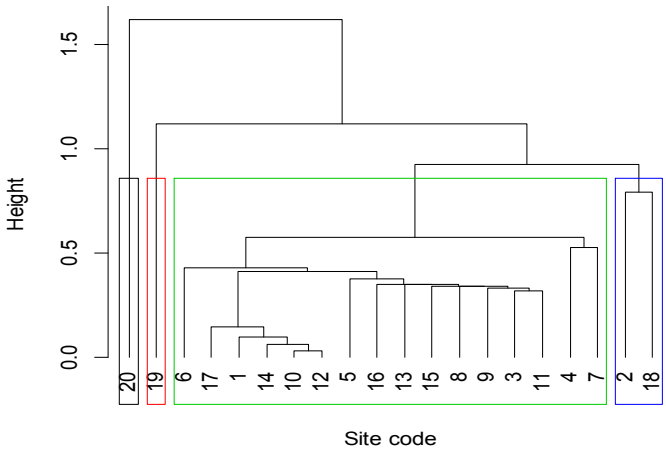

Figure 3. Dendrogram shwoing clustering of sampling sites according to noise pollution charactersitcs

Principal Componenet Analaysis

The results of the principal component analysis is shown in Figure 4a-c. Lie et al. (2003) used three classfication criteria for component loading. Loading values greater 0.75 signifies “strong”, the loading with absolute values between 0.75 and 0.50 indicate “moderate” while loading values between 0.50 and 0.30 denote as “weak”.

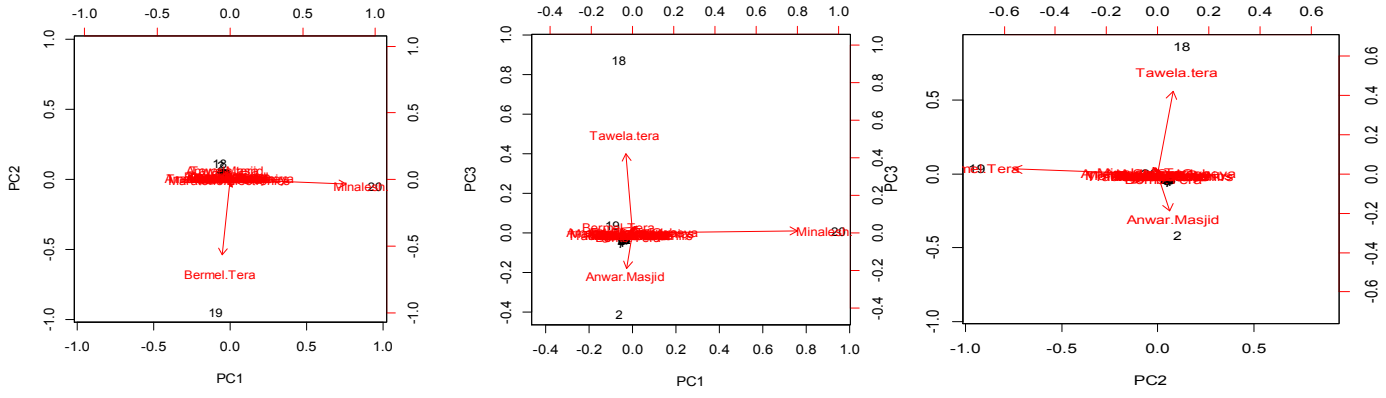

Figure 4. Score plots of the PCA analysis with the noise level data
(a: PC1 vs. PC2; b: PC1 vs. PC3; C: PC2 vs. PC3)

The first and the second principal component explain 33.7 and 17.2 % of the total variation and contain most of the information on site 20 and 19, respectively. Therefore, the first and the second principal components can be considered as a measure of nuisance on metal recycling areas. The third principal component explains 11.2% of the variation and provides information about site 18. This component can be considered as a measure of nuisance on wood workshop areas. Principal component 4 and 5 explains 9.7 and 4.9% of the total variation.

Conclusion

This study was conducted to evaluate the noise pollution status in Merkato open market in Addis Ababa. The measurement was done on five selected areas: commercial centers, road junctions; road sides; worship areas and recycling centers. The result of the measurement reveals that noise level at 19 of 20 locations exceeded the recommended limit 65 dB (A). The present status of the noise level may pose a severe health problem after prolonged daily exposure. Furthermore, it may cause discomfort, annoyance and irritation and this in turn can drastically reduce productivity in the workers. Therefore, various integrated action should be taken to control the noise level.

References

Aberra Birhanu (2011) **"**Environmental Noise Pollution in Addis Ababa; Major Sources and Public Reactions" in Noise Pollution in Addis Ababa. Forum for Environment. pp 8-28

Ali S.A. and Tamura A. (2003). Road traffic noise levels, restrictions andannoyance in Greater Cairo, Egypt. *Applied Acoustics 64 815–823*

Anomohanran O,I., Wegbue C.M.A., Oghenerhoro O. and Egbai J.C. (2008). Investigation of Environmental noise Pollution Level of Abraka in Delta State, Nigeria. *Trends in Applied Sciences Research 3(4):292-297.*

Gaganija M.S., Mkoma S.L. and Lema E.S. (2012) Attitudes of community to urban traffic noise in Morogoro, Tanzania. *Ethiopian Journal of Environmental Studies and Management EJESM Vol. 5 No. 3*

Ghatass Z. F. (2009) Assessment and Analysis of Traffic Noise Pollution in Alexandria City, Egypt. *World Applied Sciences Journal 6 (3): 433-441*

Hamed S.M., Ghodratollah S.K., Jafari A. and Dehestani S. (2008).Environmental noise pollution in the city of Khoramabad, Iran. *Journal of Environmental Science and Technology 1(4):164 – 168.*

Helgerson B. (2012) Addis Ababa Mercato: supporting emerging market economies as an alternative to developing housing. Tactical Urbanisms: Final Paper. Washington University in St. Louis

Hume K.I., Brink M. and Basner M. (2012). Effects of environmental noise on sleep. Noise and Health, 14(61): pp. 297–302.

Mato R.R. and Mufuruki T.S. (1999). Noise pollution associated with the operation of the Dares Salaam International Airport. *Transportation Research Part D, 81–89.*

Nelson P. M. (1987). Transportation Noise Reference Book. Netherlands Health Council 1997 (NHC), Committee on a Uniform Environmental Noise Exposure. Butterworth and Co., London.

Onuu M.U. (2000). Road traffic noise in Nigeria: measurements, analysis and evaluation of nuisance. *J Sound Vib 233(3):391–405*.

Phan H. Y. T., Yano T., Sato T. and Nishimura T. (2010), Characteristics of road traffic noise in Hanoi and Ho Chi Minh City, Vietnam. *Applied Acoustics; 71(5):479-485.*

Tamoczy T. (1983) Noise interference with oral communication. *Acta Physical Hungarica* volume 54 Issues 3-4, pp 337-351

Veser T. (2005) "Masterplan for the Mercato." Akzente Special: Urban Management 14-16. Retrieved August 5, 2014 from http://4ormat-asset.s3.amazonaws.com/vfs/48421/public_assets/2964514/Helgerson_urbanisms_Addis%20Ababa%20Mercato%20Economics.pdf