Civil and Environmental Research www.iiste.org
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.10, No.5, 2018

Visibility Trends in Baghdad City During the Period 2005-2014

Ahmed Hassoon Ali*
Environmental Engineering Department, Faculty of Engineering, Mustansiriyah University
PO box 10052, Baghdad, Iraq

Basim Ibraheem Wahab Al-temimi
Atmospheric Sciences Department, Faculty of Science, Mustansiriyah University
PO box 10052, Baghdad, Iraq

Younis Swadi Taliaa
Environmental Engineering Department, Faculty of Engineering, Mustansiriyah University
PO box 10052, Baghdad, Iraq

Ali Dhamin Khishala
Environmental Engineering Department, Faculty of Engineering, Mustansiriyah University
PO box 10052, Baghdad, Iraq

Abstract
Trends in horizontal visibility for Baghdad city, haziness for the period between 2005 and 2014 were assessed in view of information for daily horizontal visibility. The average (means) of annual visibility were determined for Baghdad as a whole, the results show that the average annual visibility ranged between 8592 m and 6429 m at years 2006 and 2009 respectively. However, the monthly visibility flocculate between 10385 m in November 2006 and 4216 m in May 2012. Analysis in term of linear regression was utilized for describing long-term annual trends in these variables. For the last ten years, there was a significant decreasing in horizontal visibility (-2.1 km/decade from 2005 to 2014). According to rapid increase in energy consumption, the consistent temporal and spatial variations of visibility and haze support the speculation that increased aerosol loadings were responsible for the observed decreases in horizontal visibility over Baghdad city.
Keywords: Visibility; Annual mean; percentile annual

1. Introduction

Visibility can be defined as the horizontal maximum distance, where an observer can notice the back object viewed against the horizon (Malm, 1999). The scattering of the horizontal visibility happens because of light dissipating and absorption by particles into the atmospheric that produced as a results of artificial and/or natural activities. It is a crucial consideration for daily life, particularly in surface traffic and aviation trade. Also, it had additionally importance for landscape aspect preservation, aesthetic/psychological prices, and tourism. Visibility is systematically evaluated at all the stations every place throughout the world as a typical meteorologic guideline. When the air quality is deterioration and can be noticed that by the naked eye, so the horizontal visibility is a qualitative indicator of air pollutants, without certain conditions of the weather (e.g., fog, rain, sunlight (Baumer et al., 2008). Horizontal visibility is affected by several meteorological factors, as an example, visibility observation shrunken as a result of relative humidity and air pressure, otherwise, exaggerated with temperature and wind speed (Tsai, 2005). If the visibility was poor it will affected adversely on life activates, like main road overcrowding and delaying the departure of airplanes. There are numerous investigates of long-term visibility observations assessed the impact of air pollutantion on local visibility (Molnár et al., 2008; Doyle and Dorling, 2002; Schichtel et al., 2001).

The temporal and spatial trends, and effects of manmade on the visibility of atmosphere have force in a vital thought from specialists worldwide as a part of logical and administrative investigations (Lee and Sequeira, 2001; Husar and Wilson, 1993; Trijonis, 1982; Sloane, 1982a, 1982b; 1981; Munn, 1973; Elridge, 1966). Sloane (1982a, 1982b), has analyzed the techniques to find out visibility trends as a result of air pollution. Likewise, he has also assess the inside and outside impacts of the meteorology conditions on the horizontal visibility and air quality based on the contaminations concentrations. Detailed long-term investigations of visibility and haze inside the United States have in like manner been finished by Schichtel et al., (2001), and Husar, (1979). In previous researches of Doyle and Dorling, (2002), and Lee and Sequeira, (2001), are studied the long-term of horizontal visibility in the United Kingdom and assess the patterns inside these data identified with the changing in fuel usage and meteorological conditions. Ghim et al., (2005), study the horizontal visibility throughout the period of 20 years from 1980 to 2000 in more than 60 stations in Korea. He discussed and analyzed the trends of temporal and spatial distributions of the measured data. Air contaminants ought to have assumed a part in diminished variety of visibility in Korea.

However, such organized analysis is absent in Republic of Iraq. There are a couple of past investigations have analyzed the long-term horizontal visibility observations and also the impacts of major air pollutants on local visibility (Hassoon and Wahab, 2016). Along these lines, this work endeavors to better examine the long-term visibility variations throughout the previous 10 years during 2005 to 2014 in Baghdad city/ Iraq.

2. Data and Methodology

The study area is Baghdad, the capital city of Iraq, the visibility trends station located in the Baghdad international airport (33°15'55.16"N**,** 44°14'9.96"E**).**

Prevailing visibility daytime utilized in the present research is outlined because the greatest visibility exceeded or equaled throughout a minimum of half the horizon circle, not essentially a continuous half. Trained observers are often measuring the visibility using distinctive markers at well-known distances from the meteorological locations (e.g. mountains, buildings, and towers) against the horizon. Three techniques of studying the historical trends in visibility were inspected for each station: (1) cumulative percentile, (2) annual and seasonal means visibility trends and (3) monthly visibility trends.

The Nth cumulative percentile is that the visibility is equaled or surpassed N percent of the time. Visibility data lends itself well to treatment in this method, as trends are commonly the adjustment in visibility level of a selected percentile (Sloane, 1982a). Lee, (1988), used the classifications within the Monthly Weather Report and designed a cumulative percentile plots. As simply five visibility classifications were used as a section of this investigation, linear interpolation between the categories was needed to induce the 50th percentile, or median visibility. On the off probability that the data were incessantly and usually conveyed, the 50th percentile (median percentile) would specifically relate to the median (Sloane, 1982a). At this point when connected to visibility data, wherever observations don't seem to be constantly and generally appropriated, some interpolation or extrapolation is needed in order to calculate the 50th percentile. As each Lee, (1988), and Sloane, (1982a), recognize, there's no specific reason why the 50th percentile have to be compelled to be used as a section of inclination to either the 40th or 60th percentiles, except that it a promptly used and generally understood statistic. Due to the data the descried problems, Sloane, (1982a), used the 60th and also the 90th percentiles as ‘‘good visibility days’’ and ‘‘poor visibility days’’ respectively. Within the present study, we've used the 10th, 50th, and 90th percentile to find out the best, median and poor visibility days.

3. Results and Discussion

3.1. Seasonal and Annual Visibility Trends

This is the simplest method utilized within this research. Average values have been calculated for every year as an annual mean, a winter, spring, summer and autumn mean also calculate as the seasonal mean. Also the 10th, 50th, and 90th percentile were calculated for the best, median and worst visibility. Then can be analyzed for identify either decreasing, increasing, or a combination of trends over time. The findings show that the best annual visibility trends was 8592 m at 2006, while, the worst annual visibility trends was 1718 m at 2008, as shown in **Figure 1**. These results are agreements with those obtained by Zhao et al., (2011), at Tiangin city in China. Meanwhile **Figure 2** show the seasonal visibility, for the best visibility trend (10th percentile) were 7844 m, 9185 m, 8851 m, and 9252 m for winter, spring summer and autumn seasons at years 2008, 2006, 2014 and 2006 respectively, While, for the worst visibility trend (90th percentile) for winter, spring summer and autumn seasons were 1850 m, 1350 m, 1150 m, and 1992 m occurred at years 2014, 2005, 2014 and 2012 respectively. The results in the present study show the agreements with those obtained by Samaneh et al., (2012).

3.2. Seasonal Visibility Trends

3.2.1. Winter Season

The observations analysis is based on 12 PM (local time). Noontime values are utilized as a part of these investigations type as they're additional representative of regional visibility levels, in light of the reality, that early morning radiation fogs and high relative humidity (RH%), which can reflect only the native conditions, would for the foremost half have scattered by early afternoon (Lee, 1990). Sensitivity analyses clear that selecting a different time of observation, like 9 a.m., 12 p.m. or 15 p.m., has no result on the general conclusions. The hourly data for visibility at 12 PM for nine years during the winter months were taken to find out the frequency distribution. Maximum frequency was found to be 448 at a visibility of 11500 m. However, there are few frequency distribution about 39 at a visibility from 500 to 4500 m as shown in **Figure 3.**

3.2.2. Spring Season

The hourly data for visibility at 12 PM during spring months (June, May and April) were taken to find out the frequency distribution. Maximum frequency was found to be 458 at visibility of 11500 m which is higher than in winter months for the same visibility extent. However, there are few frequency distribution about 91 at the visibility extent from 500 to 4500 m as shown in Fig. 3 which higher than that for winter season. Although, these values are still relatively small, since in this season the phenomena of pollen spread occurred and there is increased in aerosols which can affect the good frequencies of visibility.

3.2.3. Summer Season
In this season (Sep., Aug. and July), the climate temperature was very high and reached to 55 ^{o}C. The frequency distribution at 12 Pm was 324 at 11500 m. For little visibility values frequency in the range between 500-4500 m it will be had more frequencies than in winter and spring and it was 148. This is because the higher temperature degree will heating the ground surface and this will result in wind blows causes increased dust and atmosphere mixing and subsequently decreased the visibility values.
3.2.4. Autumn Season
The higher frequency distribution for visibility in the autumn months (Sep., Oct. and November) was found to be 403 at 11500 m. while for small visibility frequencies the value was 90 at 11500 m which is higher than for winter and smaller than summer while it equal to that for spring.

3.3. Monthly Visibility Trends
Throughout the period of 2005-2014, the average monthly horizontal visibility during these nine years demonstrate that, the maximum horizontal visibility was (8306 m) during September, while the minimum horizontal visibility was (6740 m) during January as shown in **Figure 4**. While, the average best and worst horizontal visibility was occurred at November (10232 m) and May (4339 m) respectively. **Figure 5** show the variation in the observed visibility along these period of Baghdad city. Furthermore, the monthly comparison of the poor and good visibilities over these period demonstrate that poor visibilities variation more than the best once as shown in **Figure 4.**

3.4. Dry extinction coefficient (RH)
To calculate the coefficient of dry extinction, the impact of relative humidity (RH) should be compensated, so that a relative correction factor must be applied (Husar and Holloway, 1984). The equations that used for this purpose are as the following:

$$\beta_{ext} = \frac{\beta_{ext}^{w}}{0.85} \qquad (RH \leq 30\%) \qquad (1)$$

$$\beta_{ext} = \frac{\beta_{ext}^{w}}{(RH-30\%)*0.05+0.85} \qquad (30\% < RH \leq 40\%) \qquad (2)$$

$$\beta_{ext} = \frac{\beta_{ext}^{w}}{(RH-40\%)*0.05+0.90} \qquad (40\% < RH \leq 50\%) \qquad (3)$$

$$\beta_{ext} = \frac{\beta_{ext}^{w}}{(RH-50\%)*0.05+0.95} \qquad (50\% < RH \leq 60\%) \qquad (4)$$

$$\beta_{ext} = \frac{\beta_{ext}^{w}}{(RH-60\%)*0.05+1.00} \qquad (60\% < RH \leq 70\%) \qquad (5)$$

$$\beta_{ext} = \frac{\beta_{ext}^{w}}{(RH-70\%)*0.03+1.05} \qquad (70\% < RH \leq 75\%) \qquad (6)$$

$$\beta_{ext} = \frac{\beta_{ext}^{w}}{(RH-75\%)*0.04+1.20} \qquad (75\% < RH \leq 80\%) \qquad (7)$$

$$\beta_{ext} = \frac{\beta_{ext}^{w}}{(RH-80\%)*0.05+1.40} \qquad (80\% < RH \leq 85\%) \qquad (8)$$

$$\beta_{ext} = \frac{\beta_{ext}^{w}}{(RH-85\%)*0.29+1.65} \qquad (85\% < RH \leq 90\%) \qquad (9)$$

Where β_{ext} is the coefficient of dry extinction, RH is the relative humidity. The wet extinction coefficient (uncorrected extinction coefficient) was calculated according to Koschmieder relationship as expressed in Eq. (10), where β^{w}_{ext} denotes the wet extinction coefficient in units of km-1 (Koschmieder,1926), Here, K is a constant and set as 1.932 based on previous studies by Griffing, (1980), and Ozkaynak et al., (1985). V denotes the observed visibility.

$$\beta_{ext}^{w} = \frac{K}{V} \qquad (10)$$

3.5. Good Tendency of Visibility
In this research, a description equation for the visibility tendency for the period from 2005 to 2014 was developed. The data was graphed and a fitting was obtained. A straight line with negative slop was obtained and this gave an indication that there is decreased in visibility trend from 9419 m at 2005 to 8670 m at 2014. The magnitude of decreasing visibility trend was 749 m which a big value. This indicates the environmental degradation and increased the air pollutants in Baghdad city among this period **.**

The visibility extent higher than 11 km which is considered to be good values were isolated. The frequency distribution was found for these and it was noticed that visibility trends value was the higher at March (78) and the smaller at June (85) which is about 50%. In general it is possible to put limitation for the good visibility values which give an indicator for good climate that is contains no or little air pollutants .

Figure 7 indicates that there are big fluctuations. The values of good visibility which is decreased into small frequencies in the last years near to 2014 and this indicate increased the pollutants gaseous and dust in

Baghdad city climate.

4. Conclusions

This paper show the horizontal visibility trends in Baghdad city during the period of 2005-2014 by utilizing a data form a metrological station located in Baghdad international airport. This paper carried out of many studies in this matter like annual, seasonal, monthly visibility at 10^{th}, 50^{th}, and 90^{th} cumulative percentiles. For annual horizontal the best visibility occurred at 2006 while in 2012 is the worst. Likewise these analysis in November the best visible trends with 10385 m in 2006 and 4216 m in May 2012 as the worst horizontal visibility. The trends of the horizontal visibility show that at the 90^{th} percentile the poor visibilities are most effected by the weather conditions.

Acknowledgement

Authors of the present work would like to thank Mustansiriyah University (www.uomustansiriyah.edu.iq) for its support to carry out this research.

Authors have declared no conflict of interest

References

Baumer D., Vogel B., Versick S., Rinke R., Mohler O., Schnaiter M., Relationship of visibility, aerosol optical thickness and aerosol size distribution in an ageing air mass over South-West Germany. Atmospheric Environment, 2008, 42, 989-998.

Doyle M., Dorling S., Visibility trends in the UK 1950–1997. Atmos. Environ., 2002, 36, 3161–3172.

Elridge R. G., Climatic visibilities of the United States, J. Appl. Meteorol., 1966, 5, 227–282.

Ferman M. A., Wolff G. T., Kelly N. A., The nature and sources of haze in the Shenandoah Valley/Blue Ridge Mountains area, J. Air Pollut. Control Assoc., 1981, 31, 1074.

Ghim Y. S., Moon K. C., Lee S., Kim Y. P., Visibility trends in Korea during the past two decades, J. Air Waste Manage. Assoc., 2005, 55(1), 73–82.

Griffing G. W., Relationships between the prevailing visibility, nephelometer scattering coefficient, and sunphotometer turbidity coefficient, Atmos. Environ., 1980, 14, 577–584.

Hassoon A. F., wahab B. I., Calculate visibility over Baghdad city depending on some atmospheric variability through 2012 , Global Journal of Advanced Research, 2016, 3(1), 12-23.

Husar R. B., Holloway J. M., Poll D. E., Wilson W. E., Spatial and temporal pattern of eastern U.S. haziness: A summary, Atmos. Environ., 1981, 15, 1919–1928.

Husar R. B., Holloway J. M., The properties and climate of atmospheric haze, in Hygroscopic Aerosols, edited by L. H. Ruhnke and A. Deepak, Deepak Publ., Hampton, Va.pp., 1984, 129–170,

Husar R. B., Poll D. E., Holloway J. M., Wilson W. E., Ellestad T. G., Trends of eastern U.S. haziness since 1948, paper presented at Fourth Symposium on turbulence: Diffusion and Air Pollution, Am. Meteorol. Soc., Boston, Mass, 1979.

Husar R. B., Wilson W. E., Haze and sulfur emission trends in the eastern United States, Environ. Sci. Technol., 1993, 27, 12–16.

Koschmieder H., Theorie der horizontalen Sichtweite Beit, Phys. Atmos., 1926, 12, 33–55.

Lee D .O., The choice of visibility statistics in the analysis of long term visibility trends in southern England. Weather, 1988, 43, 332–338.

Lee D. O., Regional variations in long-term visibility trends in the UK (1962–1990), Geography, 1994, 79, 108–121.

Lee D. O., The influence of wind direction, circulation type and air pollution emissions on summer visibility trends in southern England. Atmospheric Environment, 1990, 24A, 195–201.

Lee Y. L., Sequeira R., Visibility degradation across Hong Kong: Its components and their relative contributions, Atmos. Environ., 2001, 35, 5861–5872.

Malm W. C., Introduction to Visibility. Cooperative Institute for Research in the Atmosphere (CIRA), 1999, Ft. Collins, Colorado.

Molnár, A., Mészáros, E., Imre, K., Rüll, A., 2008. Trends in visibility over Hungary between 1996 and 2002. Atmos. Environ. 42, 26212629

Munn R. E., Secular increases in summer haziness in the Atlantic provinces, Atmosphere, 1973, 11, 156–161.

Ozkaynak H. A., Schatz D., Thurston G. D., Isaacs R. G., Husar R. B., Relationships between aerosol extinction coefficients derived from airport visual range observations and alternative measure of airborne particle mass, J. Air Pollut. Control Assoc., 1985, 35, 1176–1185.

Samaneh S., Farhang A., Yahya G., Visibility trends in Tehran during 1958-2008, Atmospheric Environment, 2012, 62, 512-520.

Schichtel B. A., Husar R. B., Falke S. R., Wilson W. E., Haze trends over the United States, 1980–1995, Atmos.

Environ., 2001, 35, 5205–5210.
Sloane C. S., Visibility trends I: Methods of analysis, Atmos. Environ., 1982, 16, 41-51.
Sloane C. S., Visibility trends II: Mideastern United States, Atmos. Environ., 1982, 16, 2309-2321.
Trijonis J., Existing and natural background levels of visibility and fine particles in the rural east, Atmos. Environ., 1982, 16, 2431.
Tsai Y.I., Atmospheric visibility trends in an urban area in Taiwan 1961–2003. Atmos. Environ. 2005, 39, 5555–5567.
Zhao P., Zhang X., Xu X., Zhao X., Long-term visibility trends and characteristics in the region of Beijing, Tianjin, and Hebei, China, Atmospheric Research, 2011, 101, 711–718.

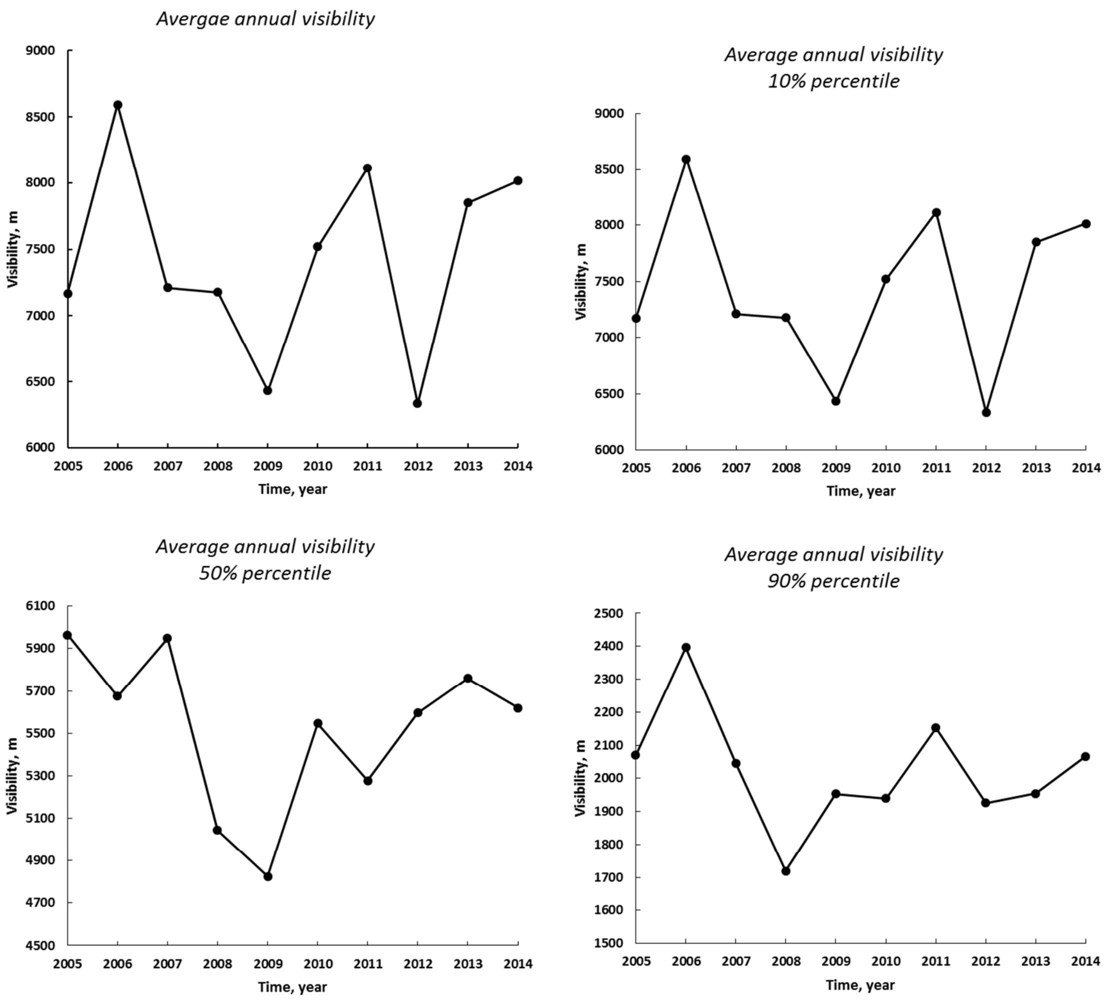

Figure 1. Average, 10th, 50th, and 90th percentile of the visibility trend

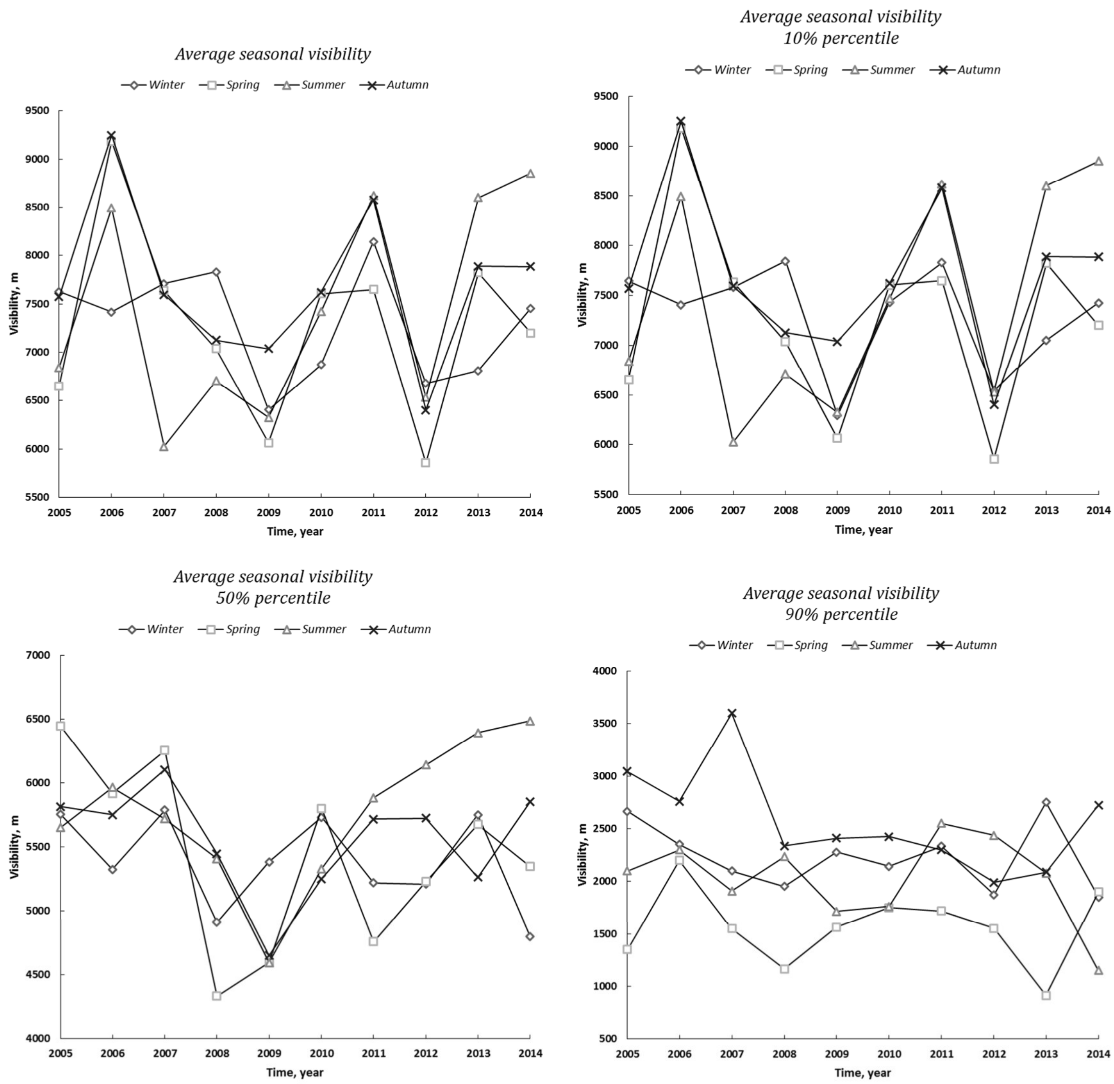

Figure 2. Average, 10th, 50th, and 90th percentile of the seasonal visibility trend.

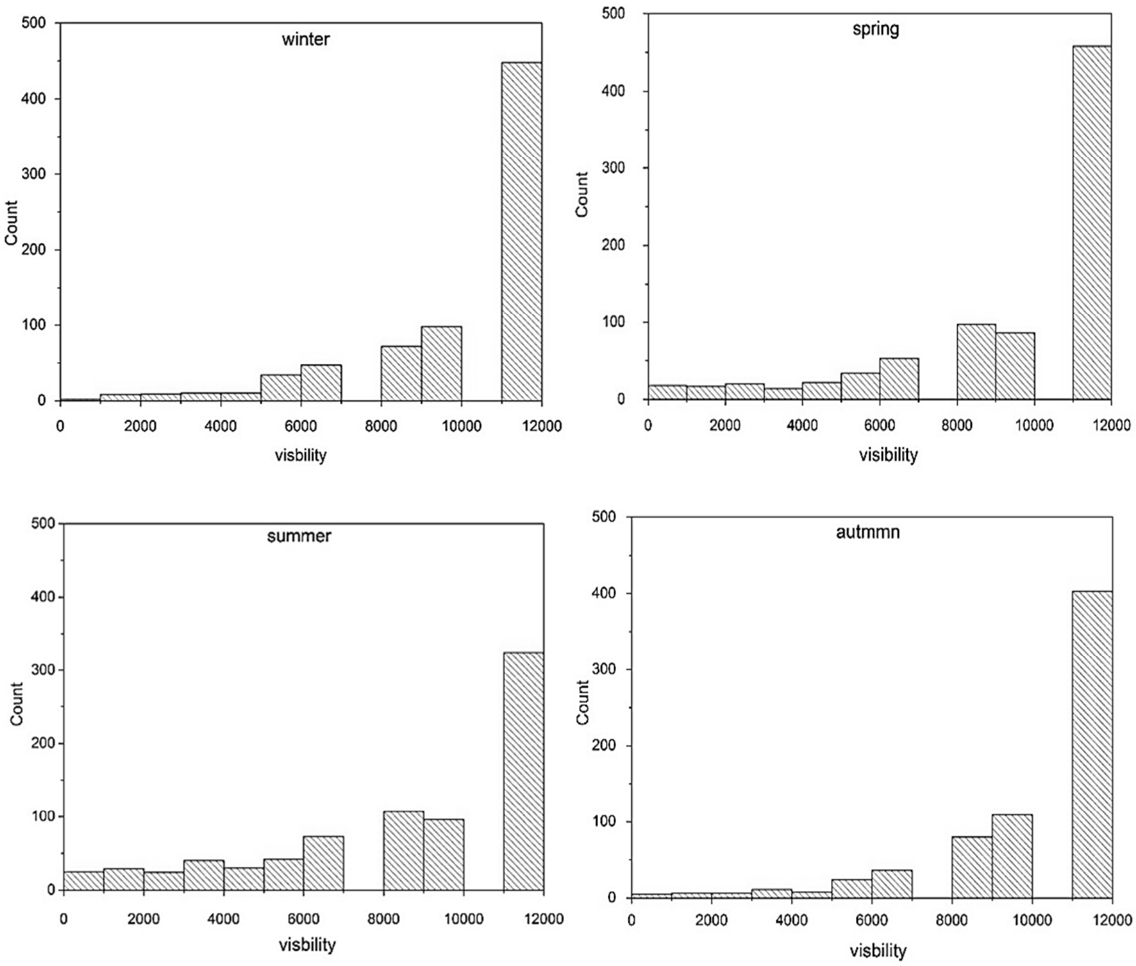

Figure 3. Frequency distribution for Seasonal visibility

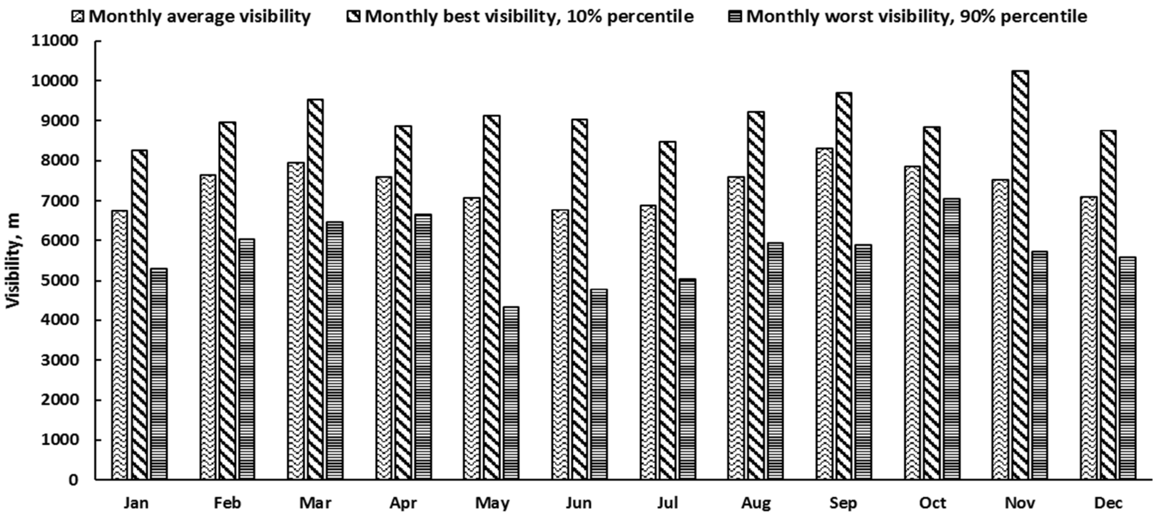

Figure 4. Monthly average, best, and worst visibilities for Baghdad city during 2005-2014.

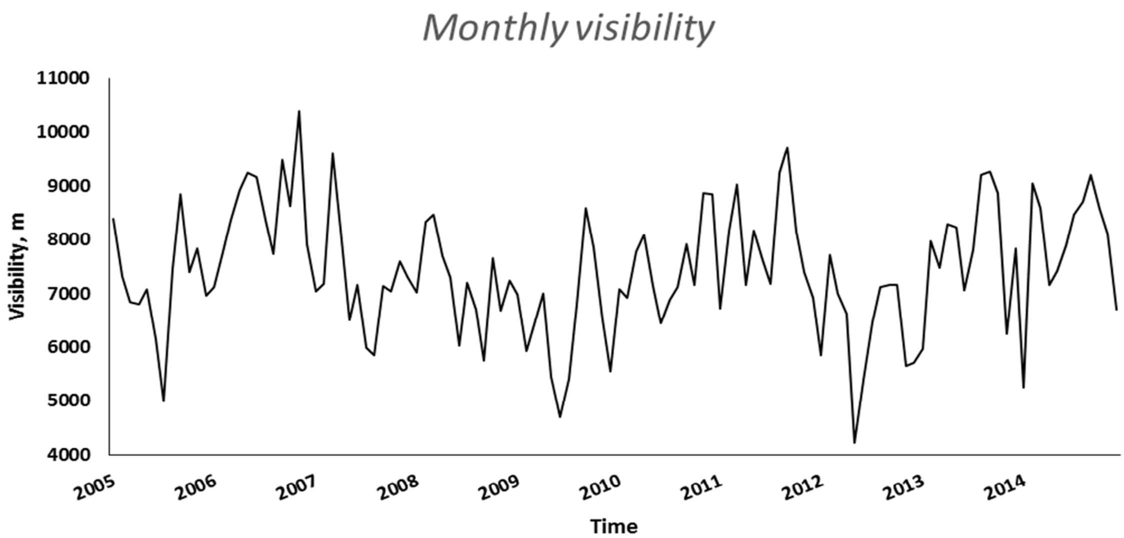

Figure 5. Average values of monthly variation of observed visibilities for Baghdad city during 2005-2014.

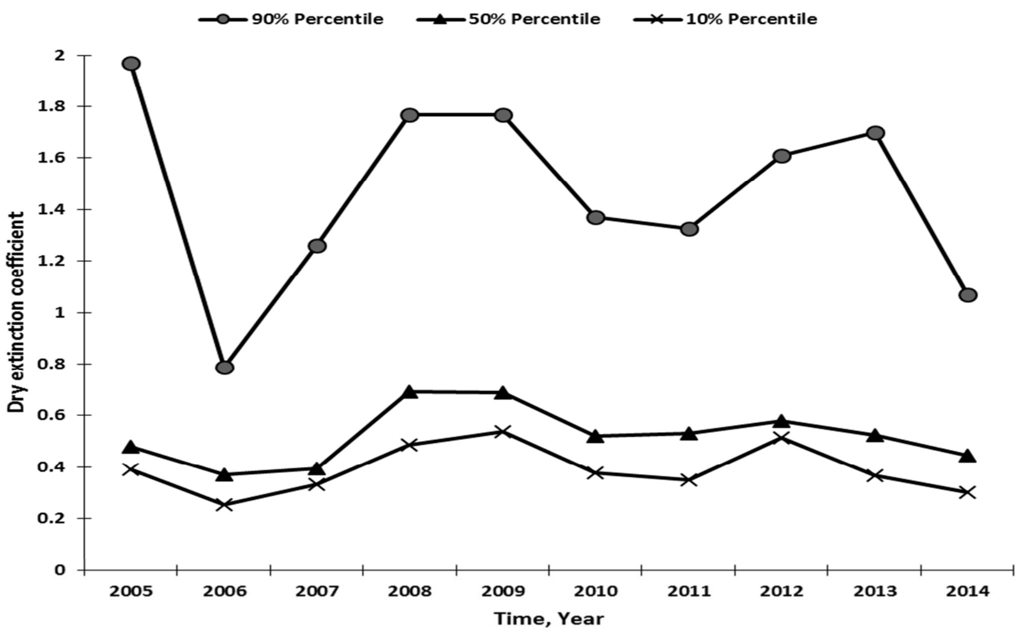

Figure 6. 90th, 50th and 10th percentile annual extinction coefficient.

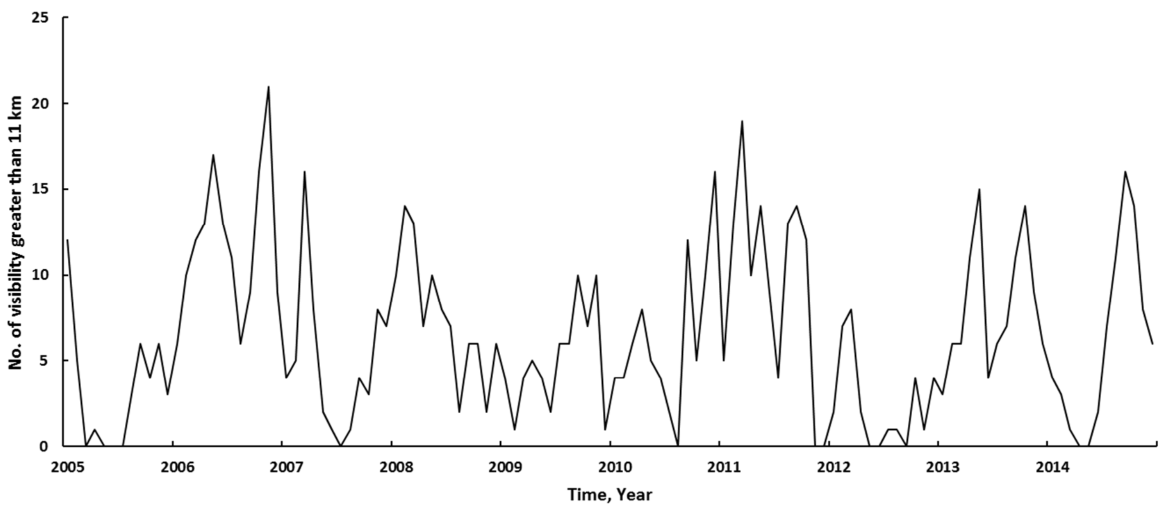

Figure 7. The tendency for good visibility frequency (greater than 11 km) during the period from 2005 to 2014 over the city of Baghdad station through all the observed period.