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CALCULATE VISIBILITY OVER BAGHDAD CITY DEPENDING ON SOME ATMOSPHERIC VARIABILITY THROUGH 2012

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ABSTRACT

Atmospheric visibility in Baghdad city is estimated at 2012 depending on air pollutants concentration such as CO, NO_2, NO_X, O_3 that recorded continuously at daytime (every half-hour) from ambient air quality monitoring AL-Waziriya station-Baghdad this station recorded also meteorological parameters such as air temperature (T), wind speed (WS) and direction (WD) these data is compared with atmospheric visibility that recorded at the same time taken from National Environment Satellite data and information service (NESDIS) for Baghdad station. All these data is analysis basically to hourly and daily. Statistical methods such as simple and multiple linear correlation coefficient is used to correlated these atmospheric variability (atmospheric elements + air pollutant gasses) with visibility, where empirical equations is put to these visibility based on these hourly and daily data. Daily data don't given a clear relationship between the calculated and observed visibility but hourly comparison is significant .The effect of polluted concentration on calculated visibility is tested from decreases gas concentration about 50% and see what its effect on the increases or decreases calculated visibility at different months and seasons, for example decreases of CH_4 concentration would have great increases in the calculated visibility in months May and December where there is increases about 200% in May and 150% in December , while ozone concentration have small effect on the visibility study show that decreases of half in O_3 will not increases the visibility in most the months and seasons of 2012 .

Keywords: atmospheric visibility, air pollution, multiple linear regression, hourly data.

1. INTRODUCTION

Visibility is the maximum distance at which one can identify a black object against the horizon, and is typically described in miles or kilometers [1]. Poor visibility can be associated with natural phenomena such as snow, rain, fog, volcanic eruption, forest fire, sand and dust storms, and so on this consider as Haze. Haze also result from human activities that cause visibility reduction, it may have severe adverse impacts on human health [2]. Haze typically starts in cities or areas with many people, but because it travels with the wind, it can appear in rural areas as well. One consequence of smog or haze over any given area is that it can change the area's climate [3]. Smog reduces the amount of the Sun's energy reaching the Earth's surface. In some cities, this reduction has been as high as 35 percent on particularly smoggy days. The reduction is greatest when the sun is low on the horizon because the sunlight has to travel through a greater amount of polluted air as its angle drops [4]. Atmospheric pollution due to coal combustion, vehicle exhaust, and industry, the primary emission sources of particles over urban area was considered to be the main cause of visibility degradation [5]., Atmospheric aerosol (or particulate matter PM) is mainly responsible for the visibility degradation due to aerosol light scattering [6].

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The submicron aerosol size range (described as PM_1 where the aerosol aerodynamic diameter is equal or less than 1.0 μm) is highly efficient in scattering of light [7]. Chemically, this size fraction comprises a large mass of Secondary Inorganic Aerosol (SIA) species ammonium (NH_4^+), nitrate (NO_3^-), sulfate ($SO4_2^-$), and chloride (Cl^-) [8]. The contribution of the particle's SIA fraction in visibility reduction has been studied and concerns mainly scattering of radiation by particulate sulfate and nitrate [9].

Visibility also important in other fields, for example during winter season, several flights are cancelled and diverted due to visibility impairment. The visibility impairment for a couple of hours can delay or stop air traffic both locally and nationwide, causing substantial monetary loss. Most of activity in the tourism is based on sightseeing and visiting places. Unfortunately, many visitors are not able to see the spectacular vistas they expect, thus because pollutant dispersion [4]. In a non-polluted atmosphere, visibility would be in the order of 250 km [5].

Over more recent years there has been a growing interest in the use of atmospheric visibility measurements as a surrogate for air pollution concentrations. Studies carried out in the United States to relate finer particulate concentrations ($PM_{2.5}$, sulphates and nitrates) with visibility degradation across the contiguous United States [10]. Concentrations of ammonium, nitrate, and sulfate can parameterized in models to calculate visibility, The Community Multiscale Air Quality Model (CMAQ) is developed by the US-EPA(United State –Environments protection Agency) and applied to simulate air quality in North China and to indicate visibility using mass concentrations of SIA species (between organic carbon and elemental carbon) [11][12]. Doyle M., (2002) also examined in depth the effect of meteorology on visibility trends and the extraction of valid, air quality related conclusions from these data[13]. In this paper we a try to estimates atmospheric visibility over Baghdad city (Iraq) depending on the real recorded data of pollutants concentration and atmospheric elements (atmospheric variability) by using different relations found in the literature.

2. DATA USED

Ministry of Iraqi environment has mainly several air quality monitoring stations at Baghdad city, its concentrated to treat the increased traffic density that makes worst air quality at Baghdad. In this research we have taken air quality data Al-Wasirya station (latitude 33.37˚ and longitude 44.38˚), this station install in industrial region neighborhood of AL-Aadhamiya, that lies north east of Baghdad city and covers an area of 1.57 km^2 surrounding by Al-Waziriya district and Muhammad Al-Kasim highway from the north, figure1.

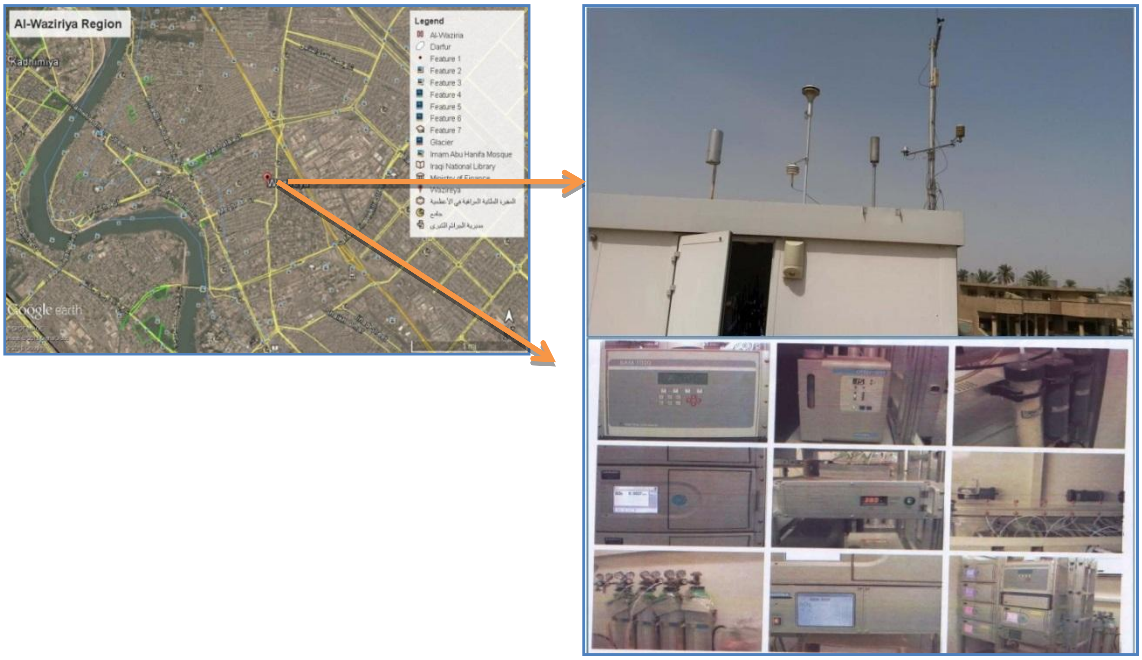

Figure 1: Air quality data Al-Wasirya station

With district of Cairo to the south and east, and Al-Mustansiriya region to the west, that mean it is in the midst of residential areas. The station consist of many devises and sensors assemblage that measured concentration of carbon monoxide (CO), nitrogen dioxide

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(NO_2), oxides of nitrogen (NOx) and Ozone (O_3) in units PPM(Part per Million) which are being monitored regularly all of it consider as continuous ambient air quality monitoring station – from HORIBA company see figure 1. The observations is momently systematically measured its transformed to hourly and daily pollutants observations , this station also recorded hourly and daily meteorological parameters like wind speed (WS) and direction (WD) in units (m/s), relative humidity (RH%) and air temperature (T) in cent greet .In this study we taken these pollutants and meteorological data for one year 2012 (data available at daytime only) with atmospheric visibility that obtain from ***The National Environmental Satellite Data and Information Service (NESDIS)*** this data available (public) as hourly for Baghdad station , it's also transformed as daily to compared with pollutant data available , see figure 2. That represents all daily data variation at 2012.

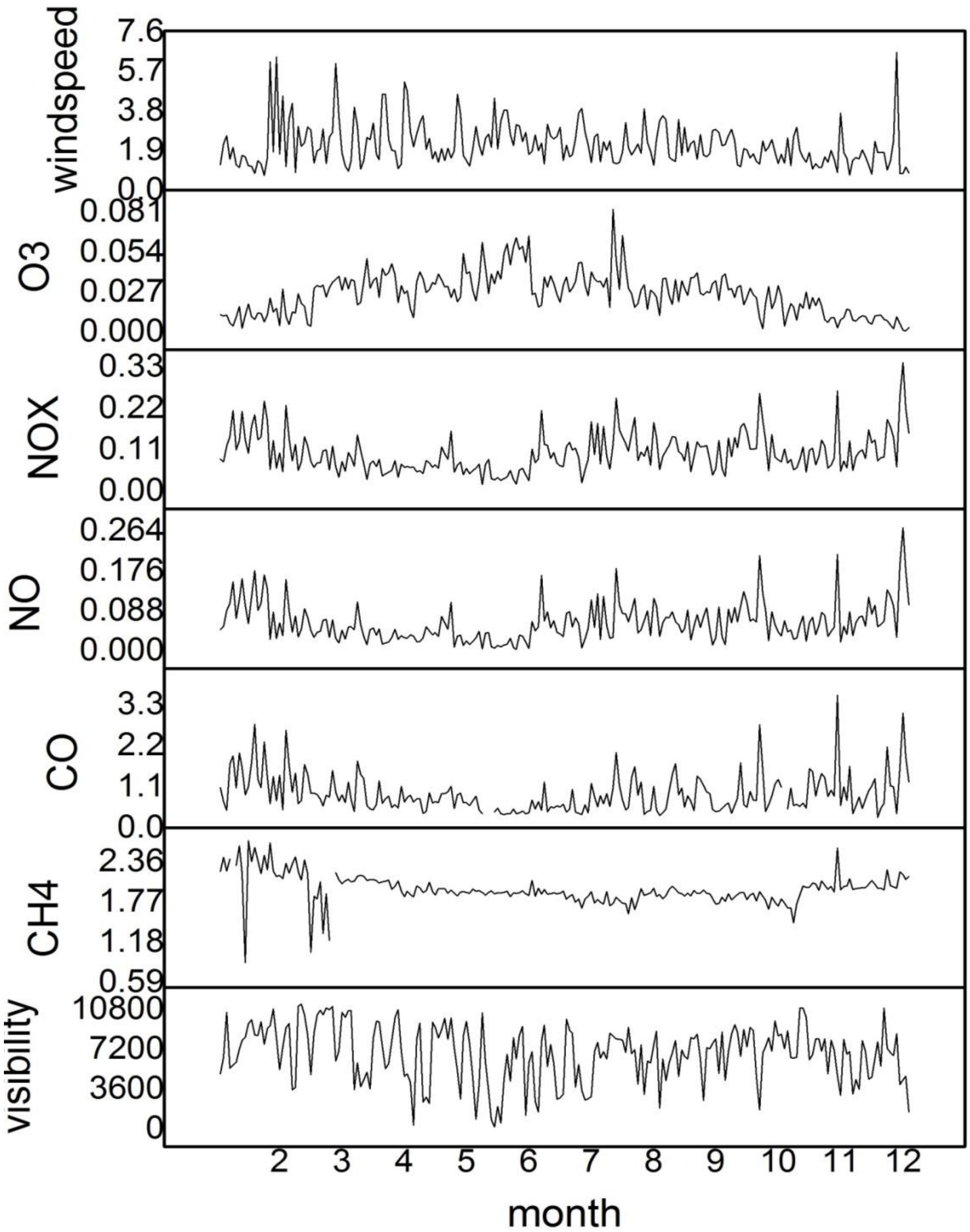

Figure 2: Daily variation of visibility (meter) and air pollutant (CH_4, NO_X, NO and CO in PPM) and Some atmospheric elements (wind speed, air temperature) at all months of 2012

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3. MATERIAL AND METHODOLOGY

Much of statistical weather forecasting is based on the statistical procedure known as simple linear regressions and multiple linear regressions, root mean square error, normalized mean square error and frictional bias. In simple linear regression (SLR), we indicate that there is only one independent variable and “linear” indicates that the model is a straight line [14]. In multiple linear regression (MLR) technique, A forecast can be expressed as a function of a certain number of variables that determine its outcome and There is one dependent variable to be predicted and two or more independent variables in the form of multiple linear regressions can be expressed as:

$$Y = b_1 + b_2x_2 + \cdots \dots \dots . . + b_kx_k + e \dots \dots \dots \dots \dots \dots \dots \dots \dots (1)$$

where Y is dependent variable, $x_2, x_3 \dots\dots x_k$ (previous day’s AQI and meteorological variables) are independent variables, $b_1, b_2, \dots\dots\dots, b_k$ are linear regression parameters, e is an estimated error term, which is obtained from independent random sampling from the normal distribution with mean zero and constant variance [15]. The task of regression modeling is to estimate the $b_1, b_2, \dots\dots\dots, b_k$ which have been done using least square technique. The regression model can be rewritten in the matrix form:

$$Y = XB + E \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . . (2)$$

Where

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} \qquad X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1k} \\ x_{21} & x_{22} & \cdots & x_{2k} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nk} \end{bmatrix} \qquad B = \begin{bmatrix} B_0 \\ B_1 \\ \vdots \\ B_n \end{bmatrix} \quad , \qquad E = \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_n \end{bmatrix}$$

The root mean square error (RMSE) has been used generally as a standard statistical metric to measure model performance in meteorology, air quality, and climate research studies. RMSE estimates the deviation of the actual y-values from the regression line. Another way to say this is that it estimates the standard deviation of the y-values in a thin vertical rectangle [16]. RMSE is computed as

$$RMSE = \sqrt{\left[\frac{\left(e_1^2 + e_2^2 + \dots + e_n^2\right)}{n}\right]} \dots\dots\dots \dots\dots\dots \dots\dots\dots \dots\dots\dots (3)$$

Emphasizes the scatter in the entire data set known as Normalized Mean Square Error (NMSE). Smaller values of NMSE denote better model performance. The expression for the NMSE is given by:

$$NMSE = \frac{\overline{(y_o - y_p)^2}}{\overline{y_o} * \overline{y_p}} \dots \dots \dots \dots \dots \dots \dots \dots \dots . (4)$$

Where

$e_i = y_0 - y_p$

y_0 =observed value

y_p = predicted value

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The verification of model can be tested also by the bias its normalized value and non-dimensionless. This fractional bias (FB) varies between +2 and -2 and has an ideal value of zero for an ideal model. It is written in symbolic form as [17].

$$FB = 2\left(\frac{\overline{y_o} - \overline{y_p}}{\overline{y_o} + \overline{y_p}}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

4. RESULT AND DISCUSSION

4.1 Simple linear regression (slr)

4.1.1 Hourly data

Simple linear regression is applied for every atmospheric variability element to test its effect on the visibility, this method taken each element separately, thus most of the SLR is weak because visibility depend on all atmospheric element perhaps don't mention in this research, these elements taken assemblage, overall you see it's there strong correlation of visibility with previous hour visibility PHVV in most of the months of study. This relation also see bold numbers that written in table 1, in the months Aug, Oct, Nov. and clear in Dec.

Table 1: Simple Hourly Correlation coefficient of atmospheric visibility with pollutants and atmospheric elements through each month at 2012 (bold numbers refer to correlation of visibility with that variable)

	Jan.	Feb.	Mar	Apr	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
PhVV	**0.857**	**0.704**	**0.868**	**0.852**	**0.903**	**0.821**	**0.768**	**0.619**	**0.739**	**0.803**	**0.701**	**0.688**
CH_4	0.090	0.0320	0.126	0.093	0.060	0.005	0.019	0.229	0.154	0.015	0.155	**0.486**
CO	0.099	0.0627	0.002	0.062	0.158	0.068	0.025	**0.345**	**0.320**	**0.407**	0.215	**0.441**
NO	0.014	0.0579	0.030	0.130	0.120	0.035	0.175	0.270	0.108	0.344	0.208	**0.480**
NO_2	0.029	0.0892	0.098	0.150	0.143	0.161	0.201	**0.465**	0.141	**0.446**	0.141	**0.414**
NO_x	0.019	0.0654	0.004	0.143	0.140	0.064	0.208	0.382	0.121	0.376	0.215	**0.509**
O_3	0.202	0.0669	0.012	0.110	**0.343**	**0.310**	0.162	0.083	0.206	0.166	**0.566**	**0.593**
Temp	0.204	0.163	0.108	0.149	**0.331**	0.065	**0.323**	0.169	0.065	0.312	**0.538**	0.256
W S	0.190	0.102	0.363	**0.383**	**0.488**	0.095	0.250	**0.498**	**0.060**	0.031	**0.701**	**0.688**

Most values of strong SLR is in the range between (0.3-0.7). these results of hourly SLR is don't founded in the seasons winter , spring , summer and Autumn table 2 were there is don't clear relation between visibility and a most of the atmospheric variability escape PHVV .

Table 2: Simple Hourly seasonal Correlation coefficient of atmospheric visibility With pollutants and atmospheric elements through each season at 2012

Atmospheric elements	Winter	Spring	Summer	Autumn
PhVV	**0.803**	**0.887**	**0.778**	**0.751**
CH_4	0.0340	0.141	0.0421	0.170
CO	0.151	0.0723	0.111	0.299
NO	0.155	0.107	0.182	0.201
NO_2	0.0727	0.135	0.286	0.174
NO_x	0.162	0.128	0.233	0.206

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O_3	*0.299*	*0.0841*	*0.154*	*0.297*
Temp	*0.0240*	*0.170*	*0.219*	*0.211*
W S	*0.0733*	***0.409***	*0.257*	*0.0703*

4.1.2 Daily data

Hourly atmospheric variability in this period study is transformed to the daily data where SLR is applied on the data to test its correlation with the visibility through the all months and season of 2012 table 3, 4. it has been found that visibility has weak (inversely proportional) , and strong (directly proportional) with some of these variable at the month and season , these results may be return to we taken one variable to comparison with visibility but overall there is increases in the number of values SLR through the months and season , and there is correlated but different in the nearly all month , in other hand the correlation of visibility with PDVV is weak and its >0.5 in months march , May and July only and spring in the daily seasonal visibility, table 4 .

Table 3: Similar to table 1, but for daily visibility.

	Jan.	***Feb.***	***Mar***	***Apr***	***May***	***June***	***July***	***Aug.***	***Sep.***	***Oct.***	***Nov.***	***Dec.***
PhVV	*0.315*	*0.325*	***0.520***	*0.397*	***0.524***	*0.142*	*0.445*	*0.388*	*0.010*	*0.360*	*0.288*	*0.253*
CH_4	*0.315*	*0.156*	***0.578***	*0.236*	*0.142*	*0.185*	*0.213*	*0.372*	*0.021*	*0.148*	*0.085*	***0.576***
CO	*0.180*	*0.085*	*0.034*	*0.187*	*0.085*	*0.181*	*0.170*	***0.557***	*0.245*	***0.580***	*0.020*	***0.429***
NO	*0.005*	*0.079*	*0.040*	*0.251*	*0.091*	*0.193*	*0.294*	*0.436*	*0.034*	***0.544***	*0.122*	***0.493***
NO_2	*0.025*	*0.017*	*0.124*	*0.275*	*0.120*	*0.120*	*0.319*	***0.698***	*0.007*	***0.585***	*0.007*	***0.568***
NO_x	*0.005*	*0.048*	*0.026*	*0.246*	*0.008*	*0.008*	*0.337*	***0.670***	*0.024*	***0.551***	*0.093*	***0.527***
O_3	***0.403***	***0.466***	*0.033*	*0.386*	***0.547***	***0.547***	*0.110*	*0.272*	*0.162*	*0.346*	***0.598***	***0.545***
Temp	*0.241*	***0.426***	*0.121*	*0.286*	***0.429***	***0.429***	*0.314*	***0.857***	*0.278*	***0.509***	***0.558***	*0.149*
W S	*0.161*	*0.232*	*0.441*	*0.403*	***0.596***	***0.596***	*0.344*	***0.716***	*0.035*	*0.095*	*0.299*	***0.497***

Table 4: Similar to table 2, but for daily seasonal visibility.

Atmospheric elements	***Winter***	***Spring***	***Summer***	***Autumn***
PhVV	*0.425*	***0.518***	*0.206*	*0.271*
CH_4	*0.0826*	*0.231*	*0.121*	*0.151*
CO	*0.205*	*0.122*	*0.293*	*0.284*
NO	*0.280*	*0.228*	*0.314*	*0.227*
NO_2	*0.192*	*0.183*	***0.407***	*0.126*
NO_x	*0.284*	*0.230*	*0.378*	*0.201*
O_3	***0.543***	*0.279*	*0.219*	*0.331*
Temp	*0.202*	*0.163*	*0.163*	*0.173*
W S	*0.178*	***0.460***	***0.460***	*0.00845*

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4.2 Multiple linear correlation coefficients

Empirical relationships have been formed between atmospheric visibility, concentration of air pollutants and meteorological parameters on daily as well as hourly basis using the multiple linear regression (MLR) technique:

4.2.1 Predicted data on the hourly basis

In this research we estimated hourly predicted values for visibility based on the hourly observed data values of air pollutants and some atmospheric elements this done by use multiple linear regressions, during the months and season from 2012 year. The visibility data resulted from this techniques is compared with the observed data. For comparison we used some of the statistical error analysis, show table 5, such as mean square error (RMSE), and fractional bias (FB) see equation 3, 4, 5. All of these indices can be used to comparison between hourly predicted and hourly observed of visibility. There is also correlation coefficient for MLR its used to test the relationships between these variables. From table 5, correlation coefficient is in range from 0.71-0.95 in monthly data, and from 0.83 -0.91 in seasonal test. Maximum value of monthly correlation coefficient is in June month. While maximum correlation value is in spring season 0.918. In other hand model is performing satisfactory with respect to normalized mean square error (NMSE) and fractional bias (FB) in October month at this month correlation coefficient is about 0.905. While other values for (NMSE) and (FB) is $4.765*10^{-5}$ and -0.00057 respectively, see figure 3. RMSE in table 5 is measure the dissipation of the data , thus the large of this standard deviation is in Nov. month 2962.6 , while small dissipation in the data about the line fitting is September 1527.44 meter .
The criteria test of hourly seasonal data in table 5 also reflects the satisfactory performance of the MLR model for hourly visibility where FB is in range (0.05 to -0.0129), NRMSE in range $1.462*10^{-5}$ to $1.837*10^{-5}$.

Table: 5 Statistical index of simulated and observed visibility through all Months and season over Baghdad city on the hourly basis

Months	Number of Observation	RMSE (meter)	NMSE	Correlation Coefficient	Fractional bias
Jan.	197	2250.7	1.09705E-05	0.718	0.003613
Feb.	162	1599.1	4.05588E-05	0.897	0.018613
Mar.	172	1755.6	2.79475E-05	0.887	-0.01192
Apr.	184	1946.7	1.61082E-05	0.921	0.270742
May	81	2573.3	2.77201E-05	0.945	-0.18675
Jun.	140	1990.9	1.25803E-05	**0.952**	0.055701
Jul.	144	1666.4	2.14793E-05	0.821	0.008993
Aug.	72	1975.8	2.94844E-05	0.907	0.056292
Sep.	116	1527.45	4.070E-05	0.752	-3.57507
Oct.	83	1529.7	**4.75696E-05**	0.905	**-0.00057**
Nov.	123	**2968.6**	1.44756E-05	0.891	-0.1275
Dec.	90	2893.8	1.54788E-05	0.902	-0.13842
Winter	**451**	**1768.4**	**1.54148E-05**	**0.835**	**-0.01294**
Spring	**438**	**1722.4**	**1.46296E-05**	**0.918**	**-0.17612**
Summer	**357**	**1767.1**	**1.83779E-05**	**0.888**	**0.05409**
Autumn	**323**	**1866.5**	**1.54859E-05**	**0.897**	**-0.01519**

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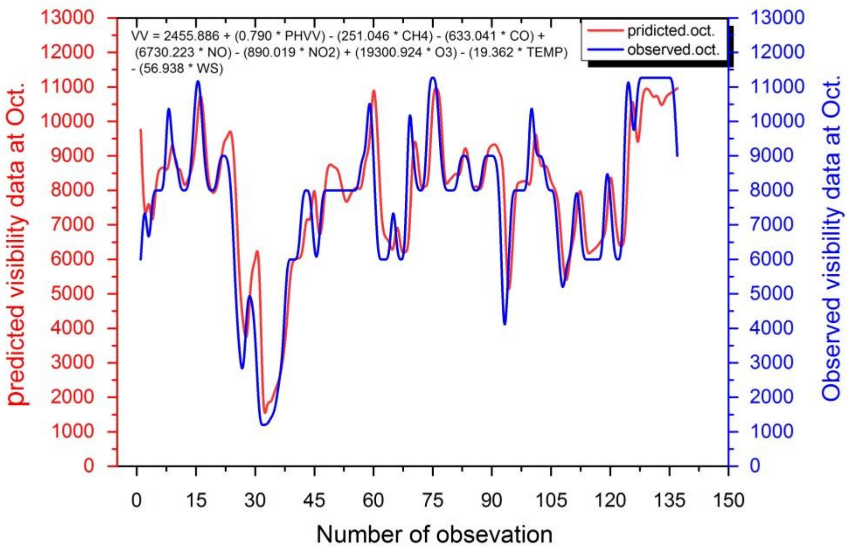
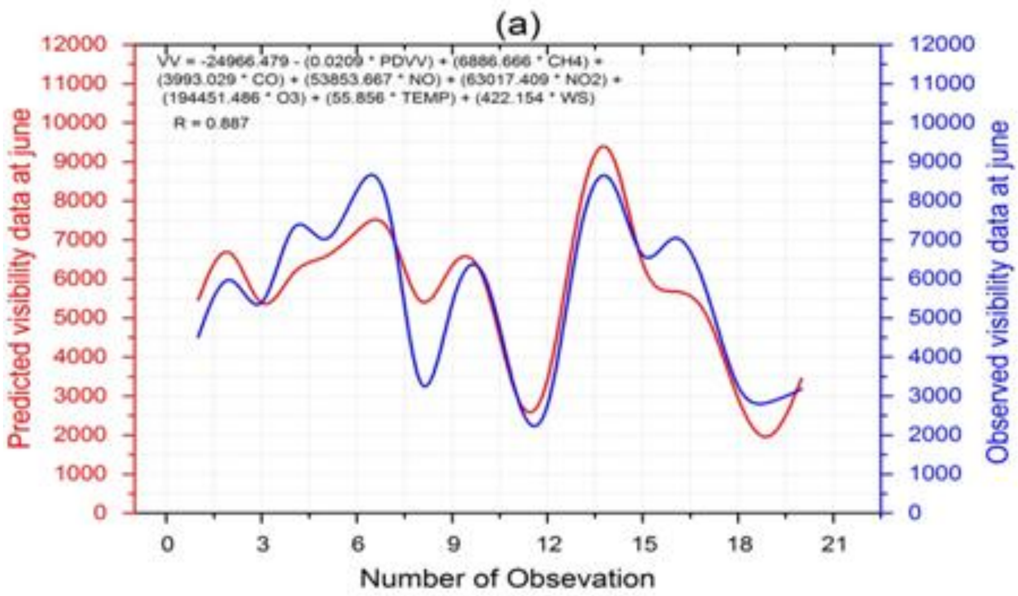


Figure 3: comparison between observed and predicted hourly visibility at October month

4.2.2 Predicted data on the daily basis

Multiple linear regressions also applied on the daily data that compression air pollutant data and atmospheric elements to test relation between these data at all months and seasons of 2012 year. The models daily visibility has been validated with observed data that measured at the same year 2012 , this done by used equations 1, which represent MLR equation, this also used to forecast daily visibility , which also compared with observed daily visibility at the same year , statistical analysis error and significant is shown in table 6 . This table indicates that model of MLR is satisfactory performed with respect to normalized mean square error (NMSE) and root mean square error (RMSE) and fractional bias(FB) for most of months and seasons , for example June month have propertied values for FB= $4.8*10^{-5}$, NRMSE=$8.738*10^{-5}$, R=0.877 figure 4(a), while September month have values $-3.76*10^{-5}$, 0.00014 for FB and NRMSE respectively and R = 0.648 see figure 4(b) .



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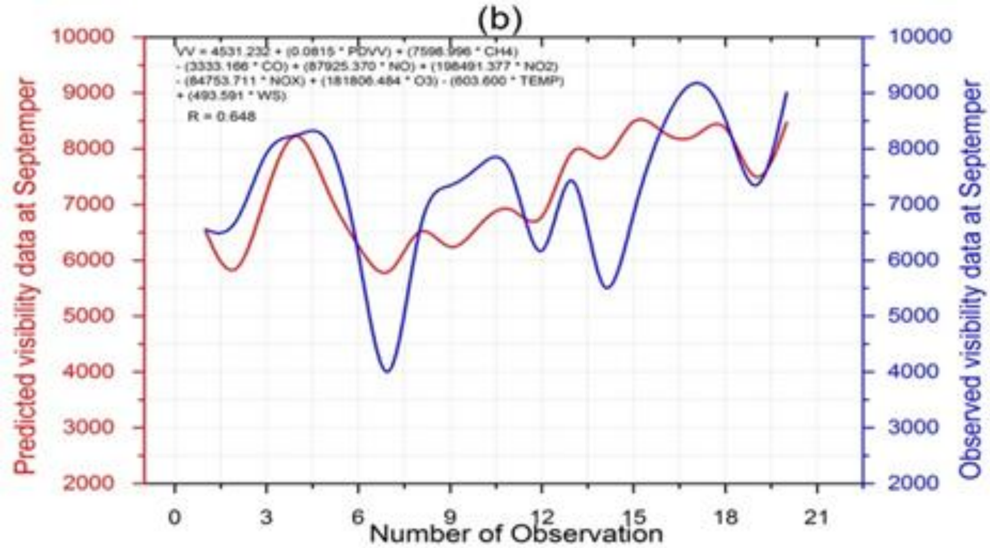

*Figure 4: Comparison between Observed and Predicted daily visibility at **(a)** June month, where there is large correlation between observed and measured visibility **(b)** September month, weak correlation in this month between observed and measured visibility values R=0.64*

Table: 6 Statistical index of simulated and observed visibility through all Months and season over Baghdad city on the daily basis

months	*Number of Observation*	*RMSE*	*NRMSE*	*Correlation Coefficient*	*Fractional bias*
Jan.	*17*	*2679.8*	*3.46602E-05*	*0.864*	*0.030406*
Feb.	*18*	*1678.4*	*0.025844*	*0.833*	*9.75001E-05*
Mar.	*14*	*1446.6*	*0.000251*	*0.854*	*-7.1E-06*
Apr.	*23*	*1468.3*	*0.000229*	*0.863*	*3.81685E-05*
May	*14*	*2144.7*	*3.4334E-05*	*0.970*	*-0.11776*
Jun.	*20*	*926.6*	***8.73826E-05***	***0.877***	***4.80115E-05***
Jul.	*24*	*1668.1*	*0.000131*	*0.638*	*-0.00032*
Aug.	*14*	*423.2*	*0.000913*	*0.974*	*2.21488E-05*
Sep.	*20*	*1275.4*	***0.00014***	***0.648***	***-3.766E-05***
Oct.	*18*	*1214.5*	*6.29144E-05*	*0.946*	*0.030978*
Nov.	*19*	*1355.6*	*0.000207*	*0.709*	*2.35509E-05*
Dec.	*15*	*1228.5*	*0.000197*	*0.824*	*0.000464*
Winter	***50***	***1849.9***	***0.000102***	***0.620***	***0.008853***
Spring	***51***	***1999.5***	***9.69642E-05***	***0.807***	***-0.02429***
Summer	***58***	***1807.1***	***8.00636E-05***	***0.609***	***-0.00042***
Autumn	***57***	***1813.4***	***0.000116***	***0.475***	***0.052646***

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4.3 Reduction of air pollutants and its effect on visibility

In this research we also examined the effect if the pollutant is reduced, we known the causes of the reduces visibility is resulted from the increases the concentration of the pollutant in the air , we test the effect of daily and hourly decrease of pollutant concentration and other atmospheric variability on the atmospheric visibility , daily decreases of atmospheric variability of this research included concentration of CH4 , NO, NO_2 ,NO_X ,O_3 and T and WS don't given clear picture about these decreases of visibility not given in these research , on the other hand hourly data is used also to concluded the visibility predicted if the pollutant is decreases , the resulted can be seen in the figure 5. its represent the rate of decreases of pollutant measured to 50% in each case to test the predicted change in visibility, we see that decreases hourly concentration of CH_4 50% resulted to increases the predicted visibility about 1.39% , 1.05% ,2.27% ,1.15% and 1.48% for months March , April, May, June and December respectively . This mean the decreases of gas CH_4 have great increases in the calculated visibility in this month, specifically at May and December where decreases of 50% of CH_4 is made visibility increases about more 200% in May and about 150% in December , see figure 5. the effect of CO on the visibility is less than where if we lessees CO concentration 50% visibility may be increases about 1.05%,1.03% 1.08%,1.10% for months February , August , September , November respectively .figure 5.

The pollutant concentration such as NO and NO_2 have rate of increases visibility in January and July about 1.72 , 1.17,1.24% and 1.21% for NO and NO_2 respectively in NO there is also increases in visibility because decreases in 50% of this pollutant and 1.15% for NO_2 in November . Ozone concentration have small effect on the visibility where decreases of 50% in O_3 is not increases the visibility in most the months see figure 5. On the other hand the seasonal decreases of hourly visibility from the hourly decreases of pollutant is also taken , Iraq have four seasons winter, spring , summer ,and autumn hourly mean visibility data for calculated visibility at these season is calculated and have values 7942.85 , 6518.46, 6009.13 and 6977.87 meter for winter , spring , summer and autumn respectively , figure 6. We notes through decreases of 50% of these pollutant concentration will increases visibility about 144.8, 284 and 681.02 meter

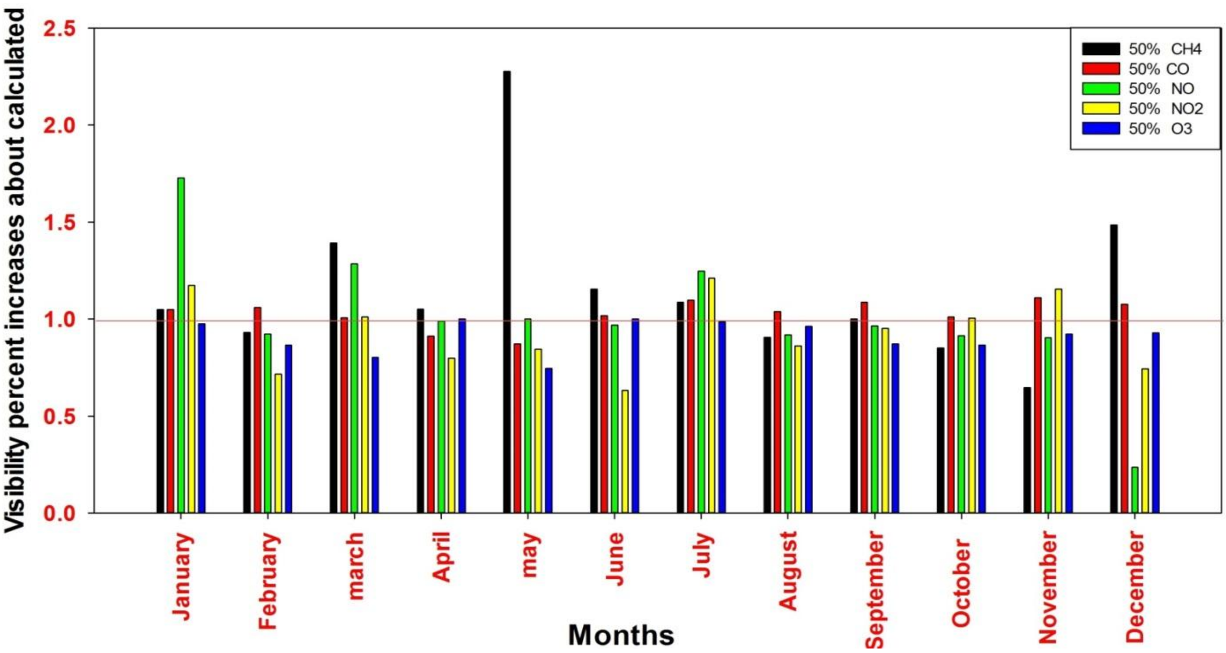

Figure 5: Percent increases or decreases in calculated visibility through the study months Because 50% decreases in atmospheric pollutant CH_4, CO,NO, NO_2, O_3 concentrations.

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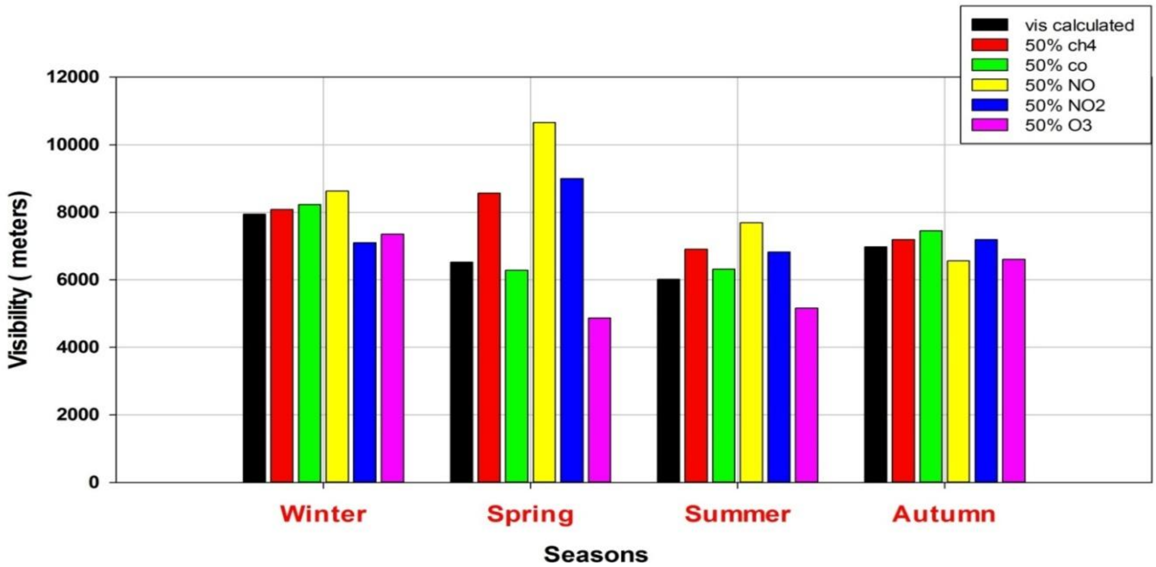

Figure 6: Increases or decreases in calculated visibility through the study seasons(2012) Because 50% decreases in atmospheric pollutant CH_4,CO,NO,NO_2,O_3 concentration,black node column refere to the visibility calculated , while other colour columns represent visibilitis values resulted from decreases air pollutant concentration

Through winter season for CH_4, CO and NO concentrations. While there is decreases in visibility about 843.6 and 593.1 meter due to decreases of 50% pollutant NO_2 and O_3, See table 7. In this table, we see that at springer, the effect of decreases pollutant concentration on the visibility increase is clear this also clear at the monthly hour at May, April and March that consisted spring season in Iraq, where decreases of 50% of NO concentration can rising visibility to about 4137.1 meter, table 7.

Table 7: Seasonal hourly increases or decreases of visibility due to sink 50% of pollutant Concentration

	50% Decreases or Increases CH4	50% Decreases or Increases CO	50% Decreases or Increases NO	50% Decreases or Increases NO2	50% Decreases or Increases O3
WINTER	144.8208	285.0868	681.0278	-843.612	-593.116
SPRING	**2050.942**	-236.292	**4137.161**	**2481.625**	-1650.69
SUMMER	900.152	305.591	1685.826	809.995	-845.446
AUTUMN	215.4127	471.509	-414.414	215.71	-370.634
Total	***3311.3 meter***	***825.89 meter***	***6089.6 meter***	***2663.7 meter***	***-3459.8 meter***

5. CONCLUSION

The calculated of visibility have very important to several applications ,this variable effected by air pollutant concentration ,where we can say that concentration of air pollutants is related negatively to the atmospheric visibility and effects the atmospheric visibility by absorption and scattering of light reaching the earth surface and can lead to visibility impairments. There are also other atmospheric elements such as temperature, dew point relative humidity and wind speed . For example increases air temperature can increases the buoyancy of the air and make air unstable, this can dissipated the air pollutant concentration by eddy waves and mixing of the air contented. Thus visibility can be positively related to air temperature increases , difference between dry bulb temperature and dew point temperature (depression temperature) is related positively with atmospheric visibility , thus visibility degradation is more like

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with decreasing dewpoint depression, this can be lead also to negative correlated of visibility with relative humidity, when humidity increases this can be lead to formation of tiny droplets suspended in air which may reduce the atmospheric visibility by inhibiting solar radiation that passed to earth surface .other atmospheric element dealing in this study is the wind speed , wind speed is positively related with atmospheric visibility , so one can say that atmospheric visibility improves if the wind speed is high and vice-versa, if wind became slow thus can lead to decreases in visibility , this may be return to that if wind speed is high it will carry a way the air pollutants with it and will help to improving the visibility of the place and reverse will happen in case of low wind speed .

In this study we concentrated on effect of these element on the visibility, by study the correlation between these element and visibility, this can be done through the applied mathematical statistical method such as SLR and MLR, from MLR we can derives the calculated visibility accordingly or from effective elements, results stated overall a good correlation between observed and measured of the visibility, this can be done by applied RMSE, NMSE and FB to test this correlated. After we sure from the significant relationship between observed and calculated visibility values, we can study the effect of these air pollutant on the visibility if we assumed that these pollutant concentration decreases about 50%. Overall some of these decreases of air pollutant contributed positively to increases visibility, while other contributed negatively to increases visibility.

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