International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 04 - Issue 02 || February 2018 || PP. 21-27

Analysis on Air Pollution in Hyderabad, Telangana State

Kuncham Srinivas, Ch.Anusha and N.Ch. Bhatra Charyulu
Department of Statistics, University College of Science,
Osmania University, Hyderabad

Abstract: In this paper we collect the twenty primary air pollutant substances are measured in Sanathnagar region of Hyderabad, Telangana state, India by the State Pollution Control Board at different time instances. A sample of 14,641 observations on 20 variables. And an attempt is made to analyze the significance of twenty variables based on 14,641 observations using some basic statistical tools and advanced multivariate statistical techniques.

Keywords: Air Pollution, Hyderabad, PCA, Cluster analysis

1. Introduction

Pollution contaminates the natural environment that cause adverse change. It can be in the form of foreign chemical substances or energy, such as noise, heat or light or naturally occurring. Air pollution is containing harmful substances including particulates and biological molecules into earth's atmosphere. It may cause diseases, allergies or death in humans and also may cause harm to other living organisms such as animals and food crops. Human activity and natural processes can both generate air pollution. An air pollutant is a substance in the air that can have adverse effects on humans and the ecosystem. The substance can be solid particles, liquid droplets, or gases. A pollutant can be of natural origin or man-made. Pollutants are classified as primary or secondary. Primary pollutants are usually produced from a process, such as ash from a volcanic eruption. An air pollutant is a substance in the air that can have adverse effects on humans and the ecosystem. The substance can be solid particles, liquid droplets or gases. Primary pollutants are Carbon monoxide (CO), Sulfur-dioxide (SO_2), Ground level ozone (O_3), Nitrogen monoxide (NO), Nitrogen dioxide (NO_2), Ammonia (NH_3), Particle pollution (Fine particles-$PM_{2.5}$, Coarse dust particles-PM_{10}), Benzene, Toluene, Xylene etc.

2. Statistical Analysis Tools:

The basic statistical tools are used for analysis like location parameter (mean) and dispersion parameter (variance) and also the correlations between variables is studied and some of the diagrams like bar charts and pie charts and line diagrams are constructed based on the values of variables. The control charts are constructed based on monthly wise data for the yearly comparison. Also principal component analysis is used for the advanced analysis. Principal component analysis is one of the multivariate statistical tool used for identifying the components accounts for most of the variation in the original data. It can be used as one of the data reduction technique with little loss of information. Let XPxN be the sample data matrix and let S be its estimated variance covariance matrix Compute the Eigen values Assume $\lambda 1 \geq \lambda 2 \geq \ldots \geq \lambda p \geq 0$. Then compute the normalized these eigen vectors. Let the Eigen value Eigen vector pairs are (λ1, e1) (λ2, e2) …(λp, ep). Then the Principal componentsY1, Y2,… Yp as the linear combination of original variables Yi = ei1X1 + ei2X2 + … + eipXp ; j =1,2,… p. Select the first few principal components explains the maximum percentage of variation. The percentage of the i^{th} principal component variance is (λi/ □ □ i) x100.

3. Data Analysis

A sample of the size 14,641 collected on 20 variables. And an attempt is made to analyze the significance of twenty variables based on all observations using some basic statistical tools and advanced multivariate statistical techniques for all variable.

3.1.Carbon monoxide (CO): It is toxic to hemoglobic animals when encountered in concentrations above about 35 ppm. In the atmosphere, it is spatially variable and short lived, having a role in the formation of ground-level ozone. Its major sources for generation are Vehicles, Back-up generators, Lawn mowers, Power washers, Incomplete combustion of wood, coal, oil, charcoal, paraffin, trash. Poisoning, Infections, Disorientation, Visual disturbance, Fainting, Seizures Its Air Quality Standard is 3.49 ppm. Maximum values in the years 2014, 2015, 2016 are 3.41ppm on 7/28/2014, 2.02ppm on 2/12/2015, 2.94ppm on 8/31/2016.

3.2. Ground Level Ozone (O_3) : Formed from NO_x and VOCs. Ozone (O_3) is a key constituent of the troposphere. It is also an important constituent of certain regions of the stratosphere commonly known as the

Ozone layer. Photochemical and chemical reactions involving it drive many of the chemical processes that occur in the atmosphere by day and by night. At abnormally high concentrations brought about by human activities (largely the combustion of fossil fuel), it is a pollutant, and a constituent of smog. It sources are Industries, Gasoline-powered vehicles, House hold paints, In summer months when wind is stagnant. It effects to health as Breathing difficulties, Eye irritation, Reduced resistance to lung infections and colds, Respiratory infections. Its Air Quality Standard: 91.69ppb. Maximum values in the years 2014, 2015, 2016 are 93.8ppb on 4/28/2014**,** 76.74ppb on 1/19/2015, 86.14ppb on 5/8/2016.

3.3. Nitrogen oxide (NO) : Nitrogen oxides, particularly nitrogen dioxide, are expelled from high temperature combustion, and are also produced during thunderstorms by electric discharge. Its major sources are Motor vehicles, Burning of coal,oil,diesel fuel and natural gas, Welding, Electroplating, Engraving, Dynamite blasting, Cigarette smoking. It effects to health as Respiratory problems, Wheezing,coughing,colds,flu,bronchitis, People with asthama and heart diseases are at more risk. Air Quality Standard is 61.58ppb. Average value for the year 2014, 2015 and 2016 are : 2.271199ppb, 1.505589ppb, 4.419738ppb. Maximum values in the years 2014, 2015, 2016 are 107ppb on 2/4/2014, 17.69ppb on 1/7/2015, 32.51ppb on 9/26/2016 .

3.4. Nitrogen DiOxide (NO_2): Nitrogen dioxide is a chemical compound with the formula NO_2. It is one of several nitrogen oxides. One of the most prominent air pollutants, this reddish-brown toxic gas has a characteristic sharp, biting odor. Its major sources are Motor vehicles, Burning of coal,oil,diesel fuel and natural gas, Welding, Electroplating, Engraving, Dynamite blasting, Cigarette smoking. Its major sources are Respiratory problems, Wheezing,coughing,colds,flu,bronchitis, People with asthama and heart diseases are at more risk. Its Air Quality Standard is 42.52ppb. Average value for the year 2014, 2015 and 2016 are : 25.08979ppb, 28.49402ppb, 29.4867ppb. Maximum values in the years 2014, 2015, 2016 are 122.1ppb on 2/4/2014, 68.79ppb on 1/13/2015, 104.09ppb on1/12/2016

3.5. Ammonia (NH_3): The main local problem of ammonia released into air is the unpleasant odour, which is detectable even at low concentrations. At particularly high concentrations it can also harm vegetation. The harm caused by ammonia in water bodies is more serious, because it is very toxic to aquatic organisms. Low concentrations of ammonia in soil are natural and actually essential for plant nutrition.On a wider scale, ammonia plays a role in the transportation and enhanced deposition of acidic pollutants - resulting in acidification of ground and water bodies, which can harm plant and animal life. Its major sources are Decaying of organic matter, Fertilisers, Industries. It effects to the health as Burning of nose throat and respiratory tract, Coughing, Skin or eye irritation. Its Air Quality Standard is 143.56ppb, 41.91269ppb, 27.14178ppb. Average value for the year 2014, 2015 and 2016 are 27.71609ppb. Maximum values in the years 2014, 2015, 2016 are 312ppb on 2/4/2014, 193.83ppb on1/16/2015, 492.35ppb on 1/3/2016.

3.6. Sulfur dioxide (SO_2) : Sulfur dioxide is a chemical compound with the formula SO_2. SO_2 is produced by volcanoes and in various industrial processes. Coal and petroleum often contain sulfur compounds, and their combustion generates sulfur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain.This is one of the causes for concern over the environmental impact of the use of these fuels as power sources. Its major sources are Base metal smelters, Fossil-fueled electric power plants, Upstream oil and gas industry, Other industrial sources (e.g. cement plants, petroleum refineries, pulp and paper mills), Transportation sources (e.g. ships, off-road diesel vehicles). It effects health to Irritates nose,throat and airways, Shortness of breath, Tight feeling around the chest. Air Quality Standard: 30.53ppb. Average value for the year 2014: 2.639056ppb, 3.255371ppb, 3.179946ppb. Maximum value for the year 2014: 41.54ppb on12/28/2014, 2015: 85.09ppb on 1/10/2015, 86.65ppb on 1/3/2016.

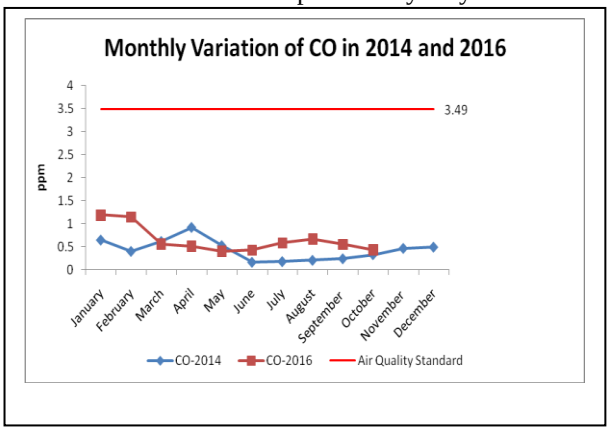
3.7. PM2.5 (Particulate Matters <2.5 micrometers) & PM10 (Particulate Matters <10 micrometers) : Particle pollution, also called particulate matter or PM, is a mixture of solids and liquid droplets floating in the air. Some particles are released directly from a specific source, while others form in complicated chemical reactions in the atmosphere. Particles come in a wide range of sizes. Particles less than or equal to 10 micrometers in diameter are so small that they can get into the lungs, potentially causing serious health problems. Ten micrometers is less than the width of a single human hair.

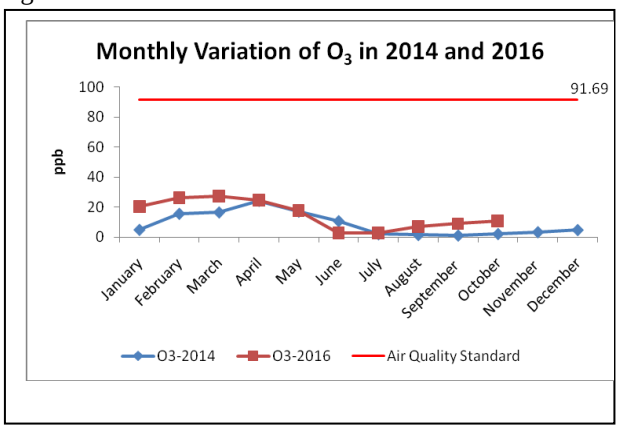
3.8. PM2.5: Its major sources are Wood burning, Motor vehicles, Power plants, Forest fires, Agricultural burning, Industrial processes. It effects to health for Coughing, Wheezing, Shortness of breath, Irritation of the eyes, nose and throat, Aggravated asthma, Development of chronic respiratory disease in children, Nonfatal heart attacks, Premature death in individuals with existing heart or lung disease, including death from lung cancer. Its Air Quality Standard is 60 µg/m³. Average value for the year 2014, 2015, 2016 are: 42.97281 µg/m³, 49.23527 µg/m³, 29.57954 µg/m³. Maximum value for the year 2014, 2015, 2016 are: 699 µg/m³ on 12/4/2014, 286 µg/m³ on 3/25/2015, 273 µg/m³ on 1/5/2016.

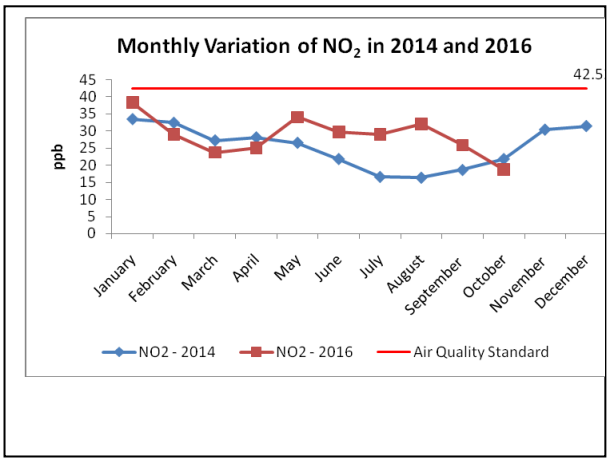
3.9. PM10: Its major sources are Crushing or grinding operations, Dust stirred up by vehicles on road. Its Air Quality Standard is _100 **µg/m³.** Average value for the year 2014, 2015,2016 are: 95.2048 **µg/m³,**102.9886

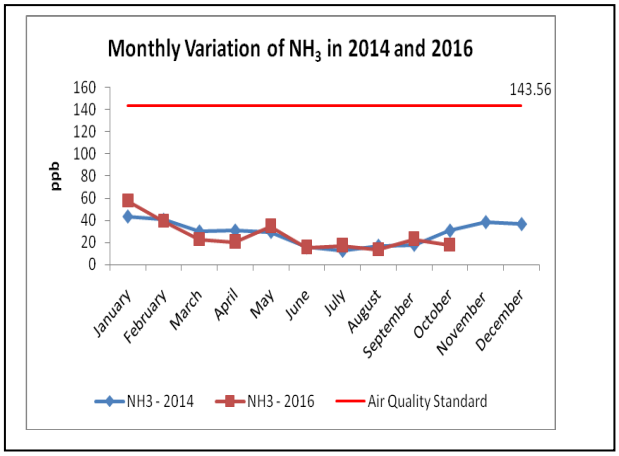
µg/m³, 72.14737 **µg/m³.** Maximum value for the year 2014: 854 **µg/m³** on 12/4/2014, 487 **µg/m³** on 3/25/2015, 486 **µg/m³** on 4/28/2016.

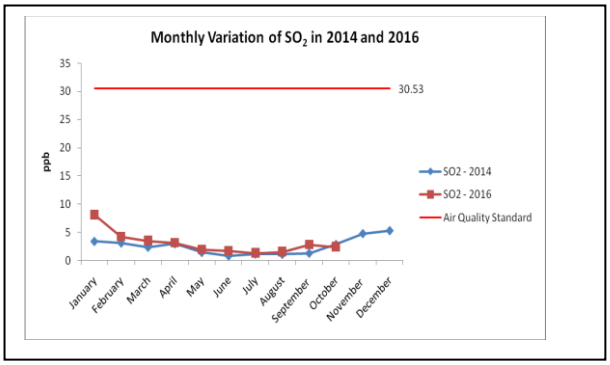
Some of the variables are represented yearly wise in line diagram.

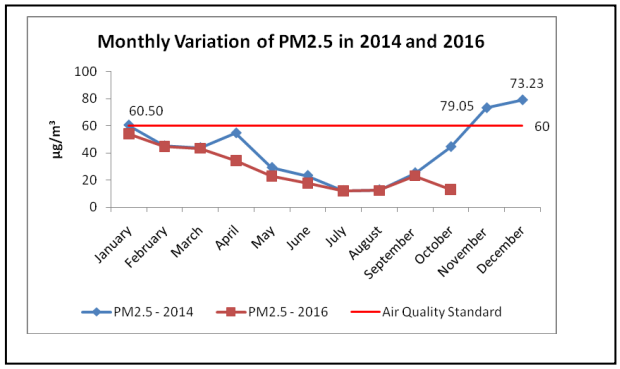


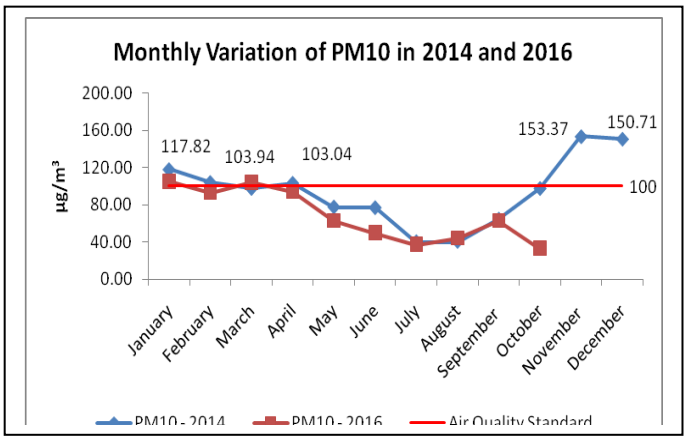




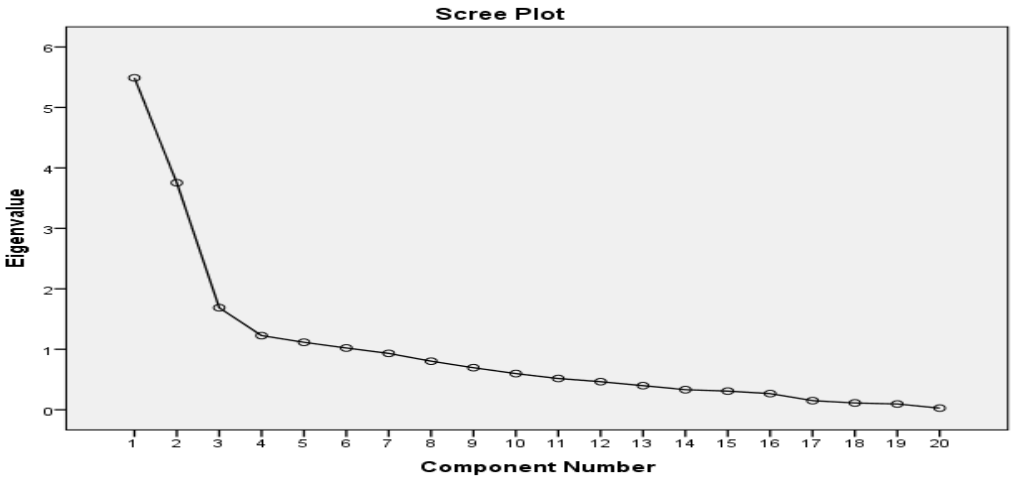








The principl component was performed to above 20 variables to remove the variables and the scree plot is given below



The communalities of the pollutanats CO, O_3, NO, NO_2, NOX, NH_3, $S0_2$, PM2.5, PM10, BEN, TOL, XYL, AT, RH, WS, WD, SR, BP, RF, VWS are 0.493, 0.661, 0.613, 0.888, 0.936, 0.696, 0.632, 0.749, 0.708, 0.695, 0.787, 0.624, 0.872, 0.869, 0.636, 0.707, 0.701, 0.878, 0.487, 0.664. The maximal variation (71%) in the six components are: (eigen values): 5.489, 3.754, 1.688, 1.226,

Total Variance Explained

Comp-onent	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of	Cumulative	Total	% of	Cumulative
1	5.489	27.444	27.444	5.489	27.444	27.444
2	3.754	18.770	46.215	3.754	18.770	46.215
3	1.688	8.438	54.653	1.688	8.438	54.653
4	1.226	6.129	60.782	1.226	6.129	60.782
5	1.115	5.577	66.359	1.115	5.577	66.359
6	1.021	5.107	71.466	1.021	5.107	71.466
7	.932	4.662	76.128			
8	.803	4.017	80.145			
9	.696	3.479	83.624			
10	.599	2.993	86.617			
11	.517	2.587	89.204			
12	.465	2.324	91.528			
13	.399	1.993	93.521			
14	.332	1.661	95.181			
15	.309	1.545	96.726			
16	.267	1.337	98.063			
17	.151	.756	98.819			
18	.113	.564	99.383			
19	.096	.480	99.863			
20	.027	.137	100.000			

Extraction Method: Principal Component Analysis.

The first six principal components can be expressed in terms of eigen vectors as:

CO	O3	NO	NO2	NOX	NH3	S02	PM2.5	PM10	BEN	TOL	XYL	AT	RH	WS	WD	SR	BP	RF	VWS
0.597	-0.012	-0.017	0.701	0.638	0.644	0.748	0.807	0.751	0.703	0.744	0.375	-0.265	-0.182	-0.551	-0.327	-0.373	0.003	-0.041	-0.45
-0.045	-0.792	0.711	0.391	0.501	-0.044	-0.061	-0.271	-0.233	-0.041	0.001	0.216	-0.665	0.852	-0.16	0.62	-0.44	-0.022	0.19	0.474
-0.283	-0.035	0.179	0.035	0.084	-0.102	0.129	-0.037	0.229	0.296	0.353	0.566	0.477	-0.192	0.288	0.426	0.497	0.05	-0.013	0.416
-0.129	0.132	0.265	0.486	0.513	0.308	-0.152	-0.106	-0.041	-0.29	-0.303	-0.249	0.294	-0.234	-0.118	-0.021	0.249	0.183	0.01	-0.058
0.181	0.059	-0.071	-0.022	-0.03	0.412	0.169	-0.103	-0.186	0.166	0.132	-0.23	-0.175	0.113	0.453	-0.167	0.214	0.295	0.52	0.227
0.068	-0.107	-0.019	-0.077	-0.079	-0.075	0.028	0.044	0.006	-0.002	-0.009	0.024	-0.118	0.08	-0.067	0.072	0.114	0.869	-0.421	-0.093

The correlation matrix is

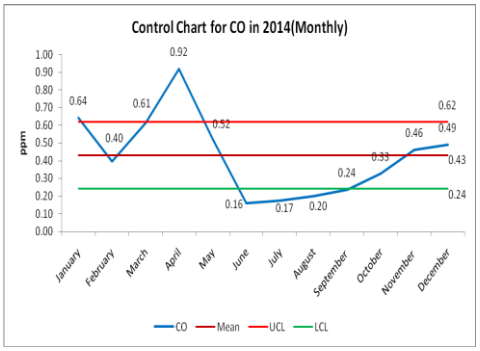
Correlations

	CO	O3	NO	NO2	NOX	NH3	S02	PM2.5	PM10	BEN	TOL	XYL	AT
CO	1	0.066	-0.03	0.317	0.283	0.352	0.359	0.484	0.342	0.346	0.359	0.075	-0.33
O3		1	-0.40	-0.250	-0.31	0.114	0.011	0.242	0.16	0.006	-0.02	-0.12	0.515
NO			1	0.266	0.447	0.016	-0.08	-0.21	-0.13	-0.04	0.003	0.194	-0.26
NO2				1	.955**	.501**	.375**	.376**	.401**	.359**	.395**	.230**	-.270**
NOX					1	.459**	.327**	.299**	.337**	.318**	.361**	.251**	-.292**
NH3						1	.498**	.435**	.332**	.370**	.370**	.086**	-.165**
S02							1	.600**	.576**	.520**	.581**	.277**	-.166**
PM2.5								1	.845**	.465**	.494**	.270**	-.079**
PM10									1	.469**	.521**	.342**	.093**
BEN										1	.829**	.325**	-.066**
TOL											1	.446**	-.079**
XYL												1	-.031*
AT													1

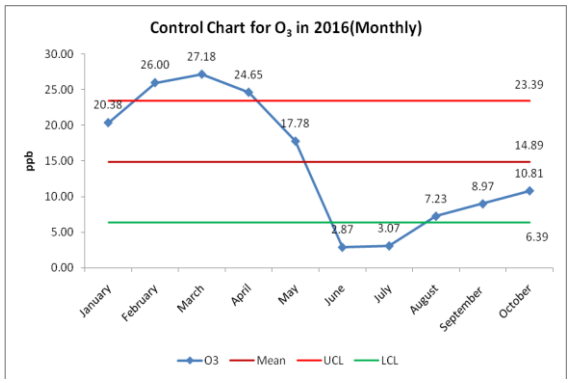
**. Correlation is significant at the 0.01 level (2-tailed).

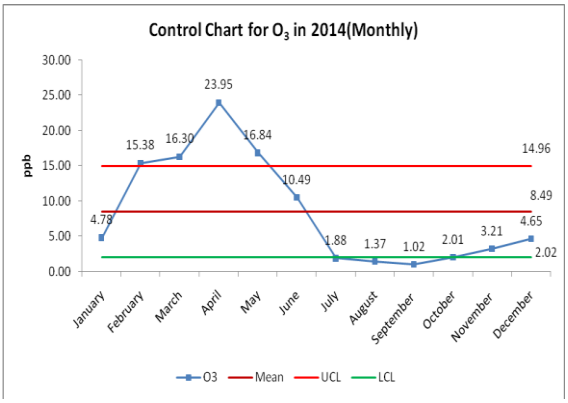
*. Correlation is significant at the 0.05 level (2-tailed).

CO

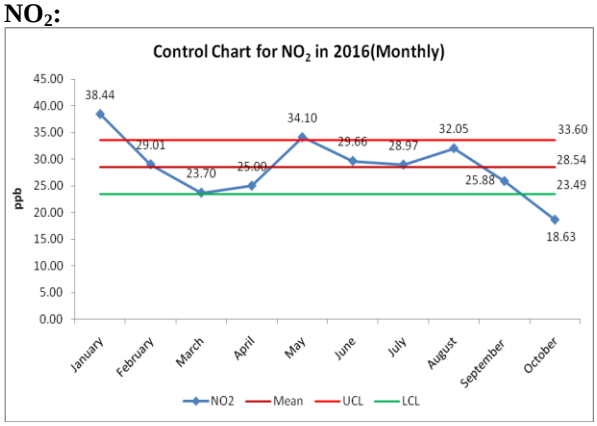


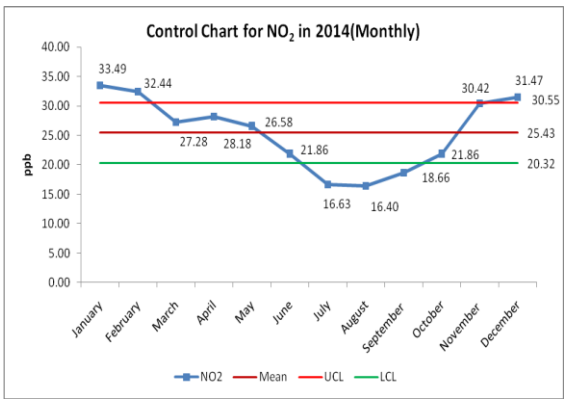
O_3:



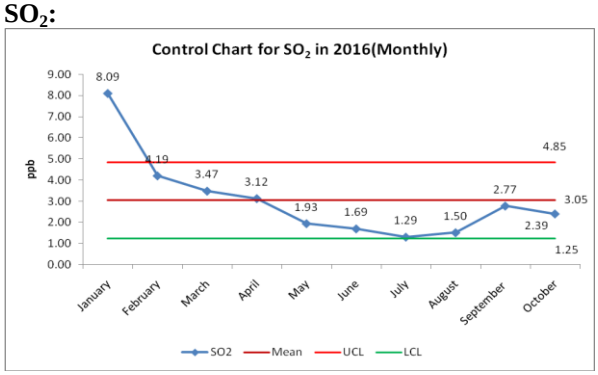


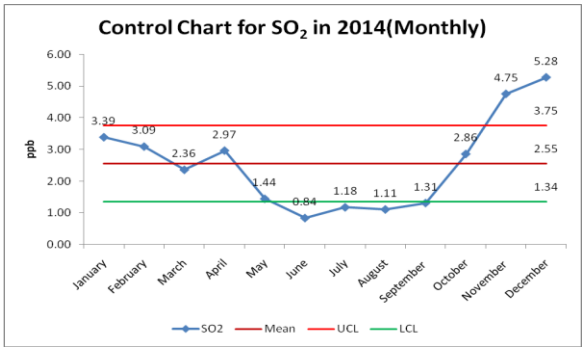
NO_2:



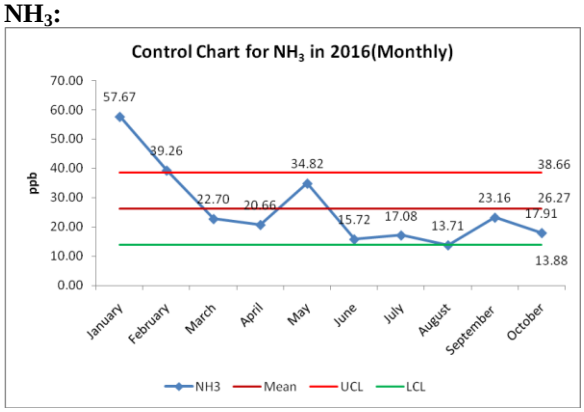


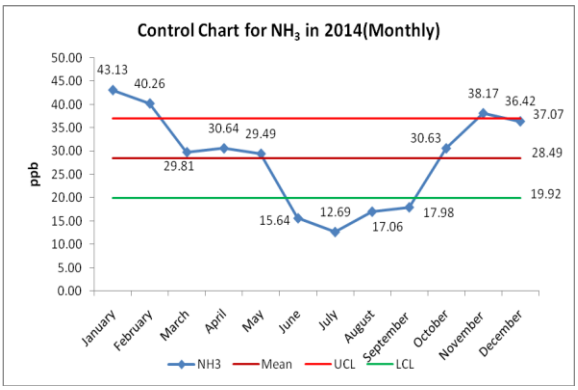
SO_2:



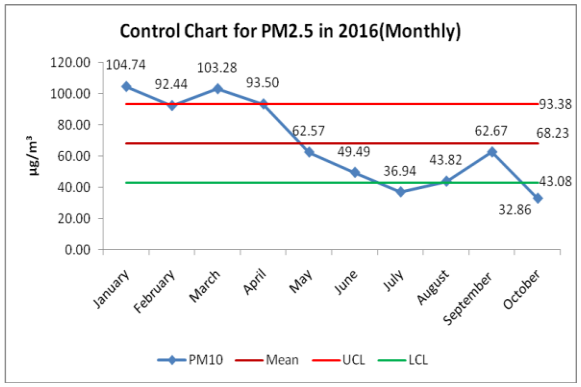


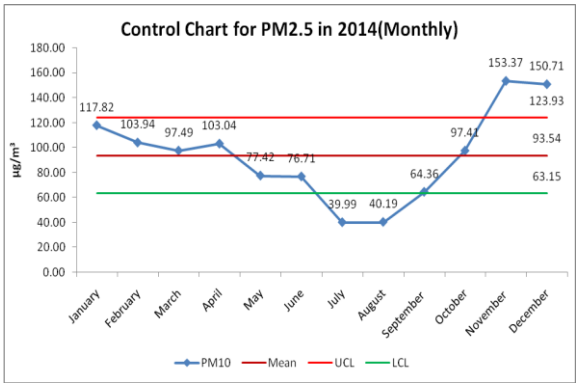
NH_3:



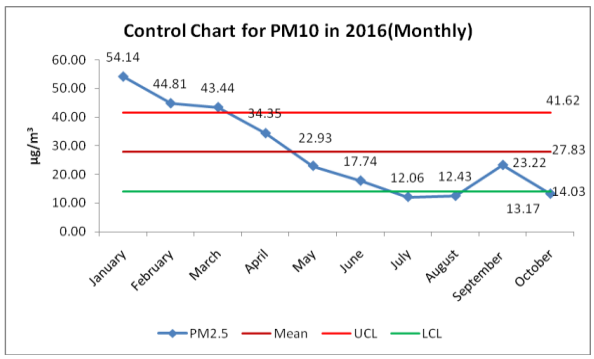


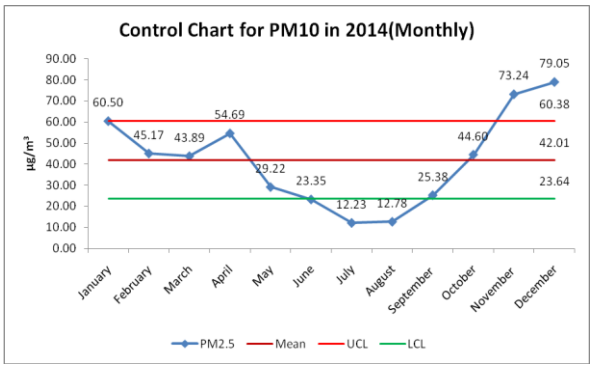
PM2.5:





PM10:





Conclusions:

1. It can be noted that even the average values are less than the standard values but in some particular periods i.e. in peak periods the values are more than standard values.
2. In almost all componenents lot of variation can be found.
3. Scree plot shows out of all the 20 components 70% variation is in the six components only. Out of the total variation around 55% variation is in the three components CO, $S0_2$ and NH_3.

References:

[1]. Johnson R.A. and Wichern D.W. (2001): Applied Multivariate Statistical Analysis, Prentice Hall of India, Third edition.
[2]. Hair J.F, Anderson R.E, Tatham R.L, Black W.C, (2003): Multivariate Data Analysis, Pearson publications, Third edition.
[3]. Cocran W.G.(1989): Sampling Techniques, Wiley Eastern Limited, Third edition.
[4]. Dixit U. J and Meena R. S.(1999): Statistical Inference and Design of Experiments, Narosa publishing house.