Global Scientific JOURNALS

GSJ: Volume 12, Issue 8, August 2024, Online: ISSN 2320-9186
www.globalscientificjournal.com

Assessment on Ambient Air Quality Standards of Bangladesh

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Abstract: WHO air quality model confirms that 92% of the world's population lives in places where air quality levels exceed WHO limits. It also denotes some 3 million deaths a year are linked to exposure to outdoor air pollution. Bangladesh is ranked as number fifth country in the world with a pollution index of 92.30. This study summarises about air quality data provided by Department of Environment (DoE), Government of the People's Republic of Bangladesh. Database consists of eleven Continuous Air Monitoring Stations (CAMS) from six different cities: Dhaka, Chittagong, Rajshahi, Sylhet, Khulna and Barisal during February 2013 and February 2015 respectively. Further, Pollutant standard Index (PSI) and its associated health risk is assessed in this study.

Keywords: Air Quality Standards, Continuous Air Monitoring Stations, Air Quality Data

Introduction: Accoding to WHO, Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution. Pollutants of major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide. Outdoor and indoor air pollution cause respiratory and other diseases, which can be fatal. The pollutant species in Bangladesh with respect to transportation systems are carbon monoxide(CO),hydrocarbons(HC),photochemical oxidants e.g., ozone (O_3), nitrogen di-oxides (NO_2), particulate matter (PM), and sulfur dioxide (SO_2). Air quality monitoring data is limited in Bangladesh, however, periodic surveys by the Department of Environment (DoE) indicate that the ambient levels of PM, $SO_2$and airborne lead are higher than the Bangladesh air quality guidelines. In new estimates released, WHO reports that one in eight of total population deaths as a result of air pollution exposure. This finding more than doubles previous estimates and confirms that air pollution is now the world's largest single environmental health risk. Reducing air pollution could save millions of lives. The present paper briefly discuss about the ambient air quality standards of 11 different air monitoring stations of 6 big cities like Dhaka, Chittagong, Rajshahi, Sylhet, Khulna And Barisal. The paper shows the location which is most vulnerable. This paper also shows the trends of various constituents like PM2.5-24 hr, PM10-24 hr, SO_2-24 hr,CO-8 hr,O_3-8 hr and NO_2-24 hr respectively.

Risk Factors:

The risk factors of total deaths from all causes for all ages are followings:

(a) High blood pressure (b) Smoking (c) High fasting plasma glucose (d) High total cholesterol (e) Ambient particulate matter (f) High sodium (g) High body mass index (h) Low whole grains Low fruit (i) Household air pollution (j) Low glomerular filtration (k) Alcohol use (l) Low nuts and seeds (m) Low vegetables (n) Low physical activity (o)Occupational particulates (p) Ozone (q) Occupational injury

Of the above 14 categories, we have studied ambient particulate matter as well as other pollutants whose global risk factor position is 5 and the number of death of population was 4.4 millions in 2015.

Table 1: Number of Death Rate per 1,00,000 of Bangladesh (Source:World Data of Air Pollution by Hannah Ritchie And Max Roser)

Year	Death Rate (Per 1,00,000)		
	Ozone	Particulate Matter	Indoor Solid Fuels
1990	3	77	99
1995	3	68	86
2000	3	66	81
2005	4	71	80
2010	4	73	80
2015	5	77	77

Methodology:

Continuous Air Monitoring Station (CAMS): In this paper, 11 CAMS station of 6 big cities of Bangladesh like Dhaka, Chittagong, Rajshahi, Sylhet, Khulna, Barisal are used to determine the air quality standards of Bangladesh.

Air Quality Monitoring Network: The program encompasses operation of the sampling and monitoring network, and quality assurance activities to ensure the quality of the data collected by the Clean Air and Sustainable Environmental Project (CASE) under department of Environment(DoE), Government of the People's Republic of Bangladesh.

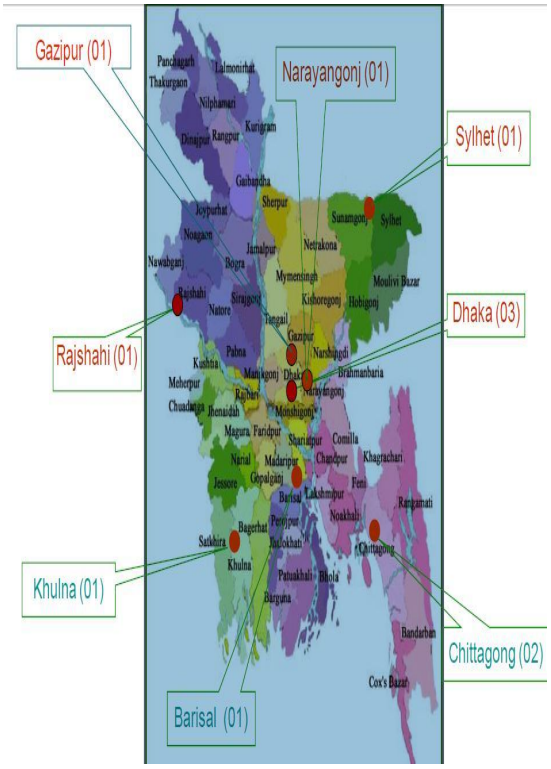

Figure 1: CAMS Location in Bangladesh

Table 2: CAMS Details Location

City	ID	Location
Dhaka	CAMS-1	SangsadBhaban, Sher-e-Bangla Nagar
	CAMS-2	Firmgate
	CAMS-3	Darus-Salam
Gazipur	CAMS-4	Gazipur
Narayanganj	CAMS-5	Narayangonj
Chittagong	CAMS-6	TV Station,Khulshi
	CAMS-7	Agrabad
Khulna	CAMS-8	Baira
Rajshahi	CAMS-9	Supara
Sylhet	CAMS-10	Red Crecent Campus
Barisal	CAMS-11	DFO Office Campus

Table 3: National Ambient Air Quality Standards of Bangladesh

Pollutant	Objectives	Average
CO	10mg/m^3(9ppm)	8 hours
	40mg/m^3(35ppm)	1 hour
NO_2	100µg/m^3	Annual
PM10	50µg/m^3	Annual(b)
	150µg/m^3	24 hours(C)
PM2.5	15µg/m^3	Annual
	65µg/m^3	24 hours
O_3	235µg/m^3(0.12pm)	1 hour(d)
	157µg/m^3(0.08pm)	8 hours
SO_2	80µg/m^3(0.03ppm)	Annual
	365µg/m^3(0.14pm)	24 hours(a)

Pollutant Standards Index(PSI):

The Pollutant Standards Index or PSIis a type of air quality index which is a number used to indicate the level of pollutants in air. Addition to the PSI derived by average data collected for the past 24 hours and Different countries also use different names for their indices such as Air Quality Health Index, Air Pollution Index and Pollutant Standards Index.

Table 4: Pollutant Standard Index(PSI) and associated health effects(Source: Singapore's National Environmental Agency,NEA)

PSI	Descriptor	General Health Effects
0–50	Good	None
51–100	Moderate	Few or none for the general population
101–200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects. To stay indoors.
201-300	Very unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.
301+	Hazardous	Health alert: everyone may experience more serious health effects

Case Study:

The Clean Air and Sustainable Environmental Project Monitoring Report 2013 and 2015 under Department of Environment(DoE), Govt. Of the People's Republic of Bangladesh were used to analyse the total study.

Table 5: Summary of Air Quality Data measured During February 2013

Parameter	Summary	CAMS-1	CAMS-2	CAMS-3	CAMS-4	CAMS-5	CAMS-6	CAMS-7	CAMS-8	CAMS-9	CAMS-10	CAMS-11
PM2.5-24hr	Avg.	127.7	128.58	149.46	147	173.3	116.9	126.9	101.5	107	100	138
	Max.	262.2	245.73	304.72	262	324.3	276.4	234.2	172.34	223	284	232
	Min.	63.33	74.04	30.59	87.4	74.99	22.13	58.06	46.82	51	54.8	74.2
PM10-24hr	Avg.	211.2	177.49	247.66	241	315.9	175.5	231.2	168.5	179	DNA	198
	Max.	380.2	353.63	486.78	407	485.1	444.5	376	293.58	353	DNA	326
	Min.	122.7	30.68	94.61	116	195.9	31.27	99.94	66.41	120	DNA	99.7
SO_2-24hr	Avg.	11.83	11.9	25.05	22.2	33.4	8.55	10.54	4.86	2	16.1	24.6
	Max.	21.64	24.7	43.07	44.1	67.18	23.49	16.16	11.48	4.5	25	51.2
	Min.	7.91	4.85	6.52	9.76	11.78	0.06	4.67	0.46	0.8	5.45	4
CO-8hr	Avg.	0.28	1.33	4.15	2.15	1.21	0.71	1.14	1.98	2.1	1.33	1.46
	Max.	0.87	6.57	6.69	4.4	3.72	2.34	2.59	5.23	13	3.37	4.54
	Min.	0.05	0.06	3.11	1.18	0.21	0.1	0.64	1.22	0.1	0.71	0.58
O_3-8hr	Avg.	8.12	19.04	13.96	21.6	11.86	8.49	32.87	16.75	9.9	23.3	14.9
	Max.	20.88	62.86	53.3	48.2	42.5	29.91	67.36	42.8	33	61.4	34
	Min.	2.82	0.12	2.99	6.85	1.69	1.24	1.44	3.23	0.8	0.28	0.82
NO_2-24hr	Avg	16.01	68.68	31.87	12.9	11.11	14.44	22	11.05	17	38.2	4.25
	Max.	34.57	98.8	49.87	19.4	17.98	30.6	52.52	20.26	18	68.2	7.2
	Min.	3.16	40.86	18.61	5.34	3.91	1.04	7.38	4.22	15	15.2	0.87

Table 6: Summary of Air Quality Data measured During February 2015

Parameter	Summary	CAMS-1	CAMS-2	CAMS-3	CAMS-4	CAMS-5	CAMS-6	CAMS-7	CAMS-8	CAMS-9	CAMS-10	CAMS-11
PM2.5-24hr	Average	118	122	142	148	175	DNA	115	113	DNA	DNA	111
	Max.	177	190	213	206	244	DNA	180	161	DNA	DNA	177
	Min.	51.77	58.8	63	66.7	81.2	DNA	57.8	71.5	DNA	DNA	46
PM10-24hr	Average	201	DNA	241	247	315	DNA	221	196	DNA	DNA	175
	Max.	314	DNA	370	344	456	DNA	287	266	DNA	DNA	298
	Min.	100	DNA	132	143	185	DNA	147	134	DNA	DNA	84
SO_2-24hr	Average	DNA	5.4	8.1	13.1	10	DNA	8.8	DNA	DNA	DNA	DNA
	Max.	DNA	12.1	15.8	24.1	20.7	DNA	14.7	DNA	DNA	DNA	DNA
	Min.	DNA	1.8	4.9	6.3	5.1	DNA	6	DNA	DNA	DNA	DNA
CO-8hr	Average	DNA	3.6	3.02	1.73	1.32	0.89	1.57	2.94	0.69	DNA	1.22
	Max.	DNA	10.8	6.33	3.13	3.52	2.47	3.23	5.36	3.16	DNA	4.86
	Min.	DNA	0.31	2	0.87	0.51	0.26	0.76	2.08	0.1	DNA	0.52
O_3-8hr	Average	DNA	DNA	DNA	DNA	5.07	DNA	17.6	12.5	7.89	DNA	12
	Max.	DNA	DNA	DNA	DNA	19.6	DNA	48.2	36.4	33.5	DNA	45
	Min.	DNA	DNA	DNA	DNA	1.43	DNA	0.38	0.51	1.06	DNA	1.08
NO_2-24hr	Average	DNA	DNA	58.4	20.4	36.9	DNA	8.8	33.1	DNA	DNA	DNA
	Max.	DNA	DNA	156	55.1	83.1	DNA	37	49.1	DNA	DNA	DNA
	Min.	DNA	DNA	12.3	3.8	13.1	DNA	4	22.3	DNA	DNA	DNA

Here DNA indicates Data Not Available. The above table is described in different units .

Here PM 2.5-24 hr and PM 10-24 hr is described in $\mu g/m^3$ unit;SO_2-24 hr,O_3-8 hr,NO_2-24 hr etc. are in ppb units; the rest CO-8 hr in ppm unit.

Result And Discussion:

Calculation of PSI value at Dhaka(CAMS-1) during February 2013:

Equation:

$$I_i = \frac{I_{i,j+1} - I_{i,j}}{(X_{i,j+1} - X_{i,j})} (X_i - X_{i,j}) + I_{i,j} \quad \text{.....(1)}$$

for $X_{i,j} \leq X_i \leq X_{i,j+1}$;Here X_i= Observed concentration for the i_{th} pollutant =127.70 $\mu g/m^3$;$X_{i,j}$ = Concentration for the i_{th} pollutant and j_{th} breakpoint as given in the table=63.33 $\mu g/m^3$;$X_{i,j+1}$= Concentration for the i_{th} pollutant and $(j+1)_{th}$ breakpoint as given in the table =262.20 $\mu g/m^3$;Here 63.33-262.20 $\mu g/m^3$ lies in Very Unhealthy Index (201-300)So, By considering Breakpoint,$I_{i,j}$ = PSI value for the i_{th} pollutant and the j_{th} breakpoint as given in the table=200 $\mu g/m^3$ $I_{i,j+1}$= PSI value for the i_{th} pollutant and the $(j+1)_{th}$ breakpoint as given in the table=300 $\mu g/m^3$;By Inputting above values in eqn.(1),

$$I_1 (PM2.5\text{-}24\ hr) = \frac{300-200}{262.20-63.33} (127.70-63.33)+200$$

$$= 232.368\ \mu g/m^3$$

By doing the same process,I_2(PM10-24 hr)=334.39 $\mu g/m^3$;I_3(SO_2-24 hr) =14.2753 $\mu g/m^3$;I_4 (CO-8 hr) =14.0244 $\mu g/m^3$;I_5(O_3-8 hr) =18.2409 $\mu g/m^3$;I_6 (NO_2-24 hr)= *

Therefore,
PSI=maximum(232.368,334.39,14.2753,14.0244,18.2409,*) =334.39 $\mu g/m^3$ *Note: Sub-index for NO_2 is only reported when the 24 hr concentration equals or exceeds 1130 $\mu g/m^3$,which corresponds to sub-index of 200. For calculating the PSI value of other locations, we have followed the same process.

Table 7: Comparison data between various periods of different locations

Location And Station	Duration:February, 2013		Duration: Februay, 2015	
	PSI Value	Index Catagory	PSI Value	Index Catagory
Dhaka (CAMS-1)	334.39	Hazardous	347.2	Hazardous
Dhaka (CAMS-2)	345.46	Hazardous	248.17	Very Unhealthy
Dhaka (CAMS-3)	439.03	Hazardous	345.3	Hazardous
Gazipur (CAMS-4)	442.72	Hazardous	351.74	Hazardous
Narayangong (CAMS-5)	441.5	Hazardous	447.97	Hazardous
Khulshi,Chittagong(CAMS-6)	434.9	Hazardous	*	*
Agrabad,Chittagong(CAMS-7)	347.55	Hazardous	252.86	Very Unhealthy
Baira,Khulna (CAMS-8)	244.94	Very Unhealthy	246.97	Very Unhealthy
Sopura,Rajshahi(CAMS-9)	325.41	Hazardous	*	*
Sylhet(CAMS-10)	219.89	Very Unhealthy	*	*
Barisal(CAMS-11)	343.66	Hazardous	335.16	Hazardous

Here, each time PSI value is governed by PM 2.5-24 hr and PM 10-24 hr.

Again * sign indicates that data is not available for that location.

Conclusion:

By the analysis of ourstudy ,we have found-

a) At Dhaka(CAMS-1), during February 2013, the PSI value observed is 334.39 µg/m^3 and associated health category is hazardous .Again during February 2015, the PSI value is found 347.2 µg/$m^3$and the associated health condition is hazardous. So ,here the PSI index category remains unchanged.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, and fumes from chemical production etc.

b) At Dhaka (CAMS-2) during February 2013, the PSI value observed is 345.46 µg/m^3 and associated health category is hazardous .Again during February 2015, the PSI value is found 347.2 µg/$m^3$and the associated health condition is very unhealthy. So ,here the PSI index category is changed.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation etc.

c) At Dhaka(CAMS-3),during February 2013 ,the PSI value observed is 439.03 µg/m^3 and associated health category is hazardous .Again during February 2015, the PSI value is found 345.3 µg/$m^3$and the associated health condition is hazardous. So ,here the PSI index category remains unchanged.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation etc.

d) At Gazipur (CAMS-4),during February 2013 ,the PSI value observed is 442.72 µg/m^3 and associated health category is hazardous .Again during February 2015, the PSI value is found 351.74 µg/$m^3$and the associated health condition is hazardous. So ,here the PSI index category remains unchanged. This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes from chemical production etc.

e) At Narayonganj(CAMS-5),during February 2013 ,the PSI value observed is 441.5 µg/m^3 and associated health category is hazardous .Again during February 2015, the PSI value is found 447.97 µg/$m^3$and the associated health condition is hazardous. So ,here the PSI index category remains unchanged.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes from chemical production etc.

f) At Khulshi,Chittagong(CAMS-6),during February 2013 ,the PSI value observed is 434.9 µg/m^3 and associated health category is hazardous .Again during February 2015, the PSI data is not available.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes etc.

g) At Agrabad, Chittagong(CAMS-7),during February, 2013 ,the PSI value observed is 347.55µg/m^3 and associated health category is hazardous .Again during February 2015, the PSI value is found 252.86 µg/$m^3$and the associated health condition is very unhealthy.

So ,here the PSI index category is changed.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants etc.

h) At Baira,Khulna(CAMS-8),during February 2013 ,the PSI value observed is 244.94 µg/m^3 and associated health category is very unhealthy .Again during February 2015, the PSI value is found 246.97 µg/$m^3$and the associated health condition is very unhealthy. So ,here the PSI index category remains unchanged.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes from chemical production etc.

i) At Sopura, Rajshahi(CAMS-9),during February, 2013 ,the PSI value observed is 325.41 µg/m^3 and associated health category is very unhealthy .Again during February 2015, the PSI data is not found.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes from chemical production etc.

j) At Sylhet(CAMS-10),during February 2013 ,the PSI value observed is 219.89 µg/m^3 and associated health category is very unhealthy .Again during February 2015, the PSI data is not found.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants etc.

k) At Barisal(CAMS-11),during February 2013 ,the PSI value observed is 343.66 µg/m^3 and associated health category is hazardous. Again during February 2015, the PSI value is found 246.97 µg/$m^3$and the associated health condition is very unhealthy. So ,here the PSI index category is changed.This happens due to vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes from chemical production etc.

Acknowledgement:

We would like to thank Ahmed Hosssain, Lecturer, Department of Civil Engineering, Rajshahi University of Engineering &Technology & Dr.A.H.M.Zulfiqur Ali, Dr. Md. JashimUddin**,**Professor**,**Department of Soil,Water& Environment**,**Fareast International University for kindly permitting to publish the present paper.

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