REPORT ON STATUS OF AMBIENT NOISE AND AIR QUALITY MONITORED DURING DEEPAVALI FESTIVAL IN BENGALURU CITY

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Contents

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A. Introduction

India is a diverse land. Himalayas in the North, desert in Rajasthan, forests in the North East, plains in the South, rivers all over, beaches in the east and west and different festivals are celebrated and cherished by people in the north, south, east and west alike. Diwali or Deepavali is the biggest and brightest Hindu festival which is embraced throughout the country regardless of faith by all religious denominations of Jains, Buddhists, Sikhs and others. Deepavali is usually celebrated between mid-October to mid-November and it may last upto five days. Deepavali is popularly known as the “festival of lights” bringing joy to the young and old all alike.

Deepavali means 'the row of lights' and is the celebration of the rise of Knowledge, the victory of good over evil symbolizing the elimination of darkness, that light empowers to commit ourselves to have good deeds closer to divinity. Traditionally, the houses are illuminated with earthen lamps or candles for the attainment of health, wealth, knowledge, peace, joy and prosperity.

B. Background

Over the years, transformation of modern belief and joy with an added advancement of technology, usage of fireworks in the festivals became the highlight of the festival. It is an indication of social status to show off more and more bursting of fireworks. Fireworks produces colorful lights and various level of sounds and leads to several short and long term impact on the environment, humans, plant and animals. The fire crackers are mainly made of four components: fuels, oxidizers, color producing agents, and binding materials.

The fuels used in the crackers are powder of Aluminum, Sulphur, Magnesium, Charcoal, Titanium, Antimony Trisulphide, Red Phosphorous, Picric Acid and Galic Acid. The oxidizing agents used are Nitrate of Potassium, Strontium, Sodium, Barium and chlorate of Potassium, Ammonium, Barium. The color producing chemicals contained in the crackers are Carbonate of Strontium, Calcium, Sodium, Barium and other oxalates and heavy metals. The binding materials

are Shellac, Silicon, Starch, Iron, Linced Oil, Clay, Dextrin, Realgar and other lot more chemicals.

Bursting of fire crackers produce large quantity of smoke, dust, toxic ashes, acidic fumes sulfur dioxide, oxides of nitrogen, carbon monoxide and various other inorganic particles. The blistering emission comes out from firecrackers deleteriously affects primarily the human health, animals and all living things.

C. Objectives

To ensure compliance of the Hon'ble Supreme Court Order dated 5th October 1999 & 27.09.2001and to protect the health of human beings and Environment, Central Pollution Control Board, Zonal Office, Bengaluru is monitoring ambient air and noise level during deepavali since many years. To study the impact of bursting of fire crackers during deepavali, 2015, ambient air quality and noise monitoring was carried out with the following objectives:

- To assess the ambient noise and air pollution level caused by bursting of crackers.
- To provide the information to the regulators and planners as to implement the control measures.
- To create awareness about the ill-effects caused by the crackers and in general by pollution.
- To educate the public about the legal provisions supporting to protect the environment and health.
- To study the status trend of pollution over the years during Deepavali.

D. Ambient Noise and Air Quality Monitoring Locations

Central Pollution Control Board (CPCB), Zonal Office, Bengaluru carried out ambient air quality monitoring at three locations in Bengaluru during November 5-6, 2015 (normal day) and during November 11-12, 2015 (Deepavali day) from 6 A.M to 6 A.M on 24 hourly basis. Noise monitoring was also carried at same locations on November 5 & 11, 2015 between 17.00 hrs. to 24.00 hrs. The locations of air quality and noise level measured by both manual and online continuous stations are listed below in Table-1 and also depicted in Figure-1.

Table-1: Ambient Air and Noise Monitoring Locations

Sl.No	Locations	Zone	Longitude (East)	Latitude (North)
Name of Locations of Ambient Noise level Measured by Manual method				
1	RT Nagar	Residential	77°35.727"	13°01.721"
2	Basaveshwar Nagar	Residential	77°32.674"	12°59.062"
3	Rajarajeswari Nagar	Residential	77°31.346"	12°31.231"
Name of Locations of Noise level Measured by Online continuous method				
1.	Peenya	Industrial	77°30´11.45	13°1´4.28"
2.	MG Road	Commercial	77°34´15.44	12°58´38.54
3.	Shivanahalli	Residential	77°35´40.15	12°59´0.54"
4.	Kadabeshnahalli	Residential	77°34´34.58	12°54´45.45
5.	BTM Layout	Residential	77°35´10.96	12°54´30.36
6.	Yeswanthpur	Residential	77°33´28.13"	13°1´5.04"
7.	White Field	Industrial	77°45´5.18	12°56´15.27
8.	Domlur	Residential	77°38´17.78	12°57´48.86
9.	RVCE College	Commercial	77°29´58.5"	12°55´23.15
10.	NIMHANS	Silence	77°35´32.95	12°56´15.27
Name of Locations of Ambient Air Quality Measured by Manual method				
1.	RT Nagar	Residential	77°35.727"	13°01.721"
2.	Basaveshwar Nagar	Residential	77°32.674"	12°59.062"
3.	Rajarajeswari Nagar	Residential	77°31.346"	12°31.231"
Name of Locations of Ambient Air Quality Measured by Online continuous method				
1.	Peenya	Industrial	77°30´11.45"	13°1´4.28"
2.	BTM Layout	Residential	77°35´10.96"	12°54´30.36"
3.	Kadabeshnahalli, (BWSSB)	Residential	77°34´34.58"	12°54´45.45"

The pollutants measured are Respirable Suspended Particulate Matter (PM_{10}), $PM_{2.5}$ and the gaseous pollutants are Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_x) in the manual monitoring. In Noise Measurement, the parameters are Leq dB (A), percentiles of L10, L50, L90, Lmin, Lmax etc. In the continuous ambient air quality monitoring about 7-9 pollutants and 6 meteorological parameters are measured on 24 hours basis.

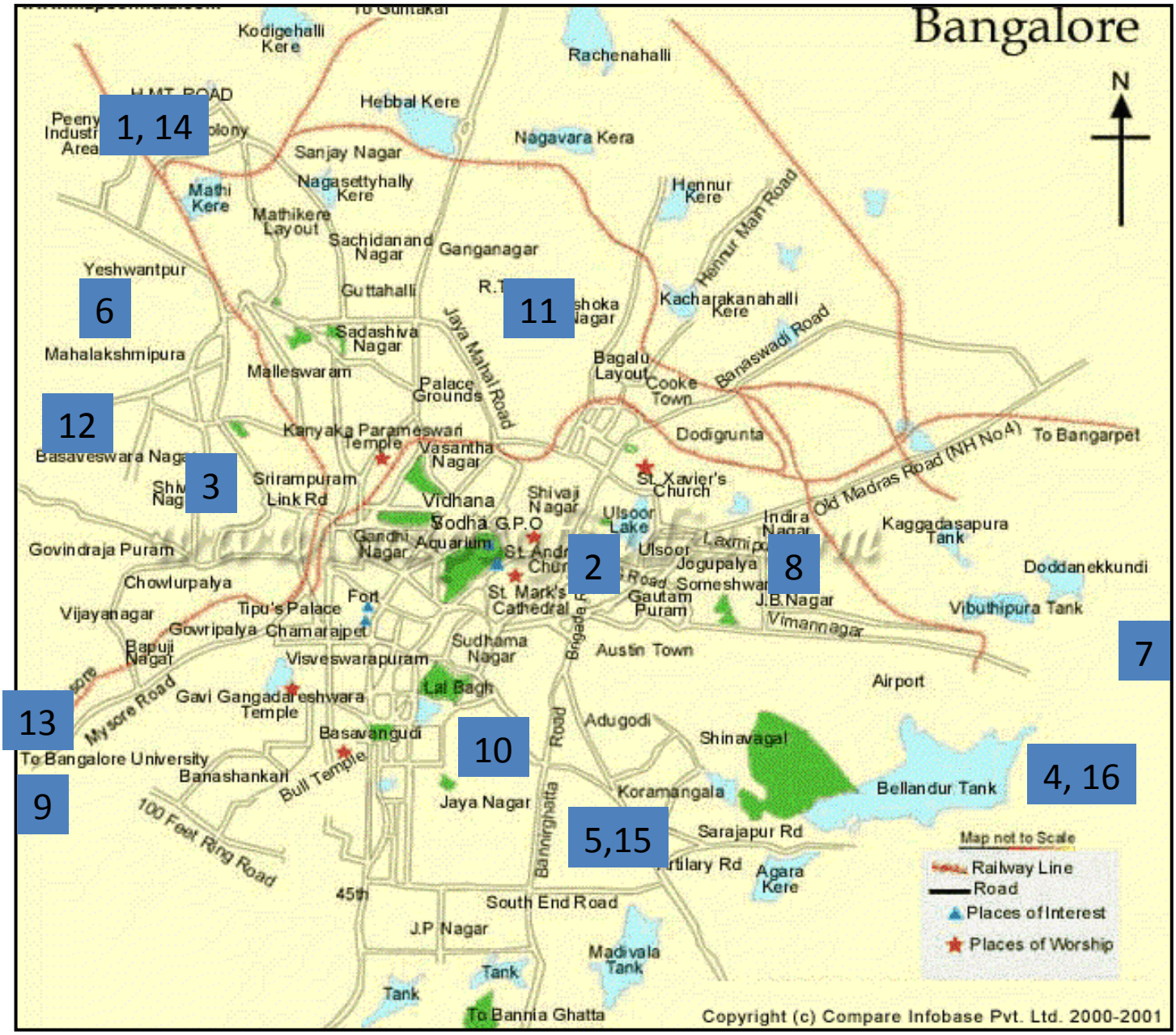


Figure-1: Monitoring Locations

1.	Peenya	9.	RVCE College
2.	MG Road	10.	NIMHANS
3.	Shivanahalli	11.	RT Nagar
4.	Kadabeshnahalli	12.	Basaveshwarnagar
5.	BTM Layout	13.	Rajarajeswari Nagar
6.	Yeswanthpur	14.	Peenya
7.	White Field	15	BTM Layout
8.	Domlur	16.	Kadabeshnahalli, (BWSSB)

E. Results and discussion

E1. Ambient Noise Level Monitoring

Ambient Noise level was measured using a Type 1 integrating sound level meter with free-field microphone which meets the Accuracy of noise certifying standards as per IEC 804 (BS 6698) Grade I or ANSI Type I or equivalent IEC 61672-1(2002-05) Class-I.

The ambient noise level monitoring was carried out at three residential locations namely Basaveshwar Nagar, Rajarajeswari Nagar and RT Nagar manually both on Normal Day (05.11.2015) and Deepavali Day (11.11.2015) during 17.00 hrs. to 24.00 hrs. The average noise levels recorded both on normal and deepavali days are presented in Table-2.

The noise level data measured at all 3 locations indicates that the highest level 91 Leq.dB(A) is recorded at RT Nagar and followed by 82 Leq.dB(A) at Basaveshwar Nagar and 69 Leq.dB(A) at Rajarajeswari Nagar during Deepavali period which are exceeding the standard limit of 55 Leq.dB(A) prescribed for residential area for day time. The noise level recorded during normal day is also exceeding the standard. The percentage of exceedance during Deepavali period is ranging from 18% to 60% and on normal day it is ranging from 1% to 7%. The average L. equivalent levels of each location for both normal and Deepavali days with respect to the standard limits are depicted in Figure-2.

Table-2: Status of Ambient Noise Level measured manually in Bengaluru on Normal Day (05.11.2015) and Deepavali Day (11.11.2015) during 17.00hrs to 24.00 hrs

Noise Levels	**Basaveshwar Nagar**		**Rajarajeswari Nagar**		**RT Nagar**	
	Normal Day	Deepavali Day	Normal Day	Deepavali Day	Normal Day	Deepavali Day
Leq(A)	64	82	56	69	69	91
Min	40	35	39	42	41	48
L90	55	57	46	53	60	63
L50	62	78	49	55	65	72
L10	65	62	55	64	72	86
Max	92	114	98	102	95	119

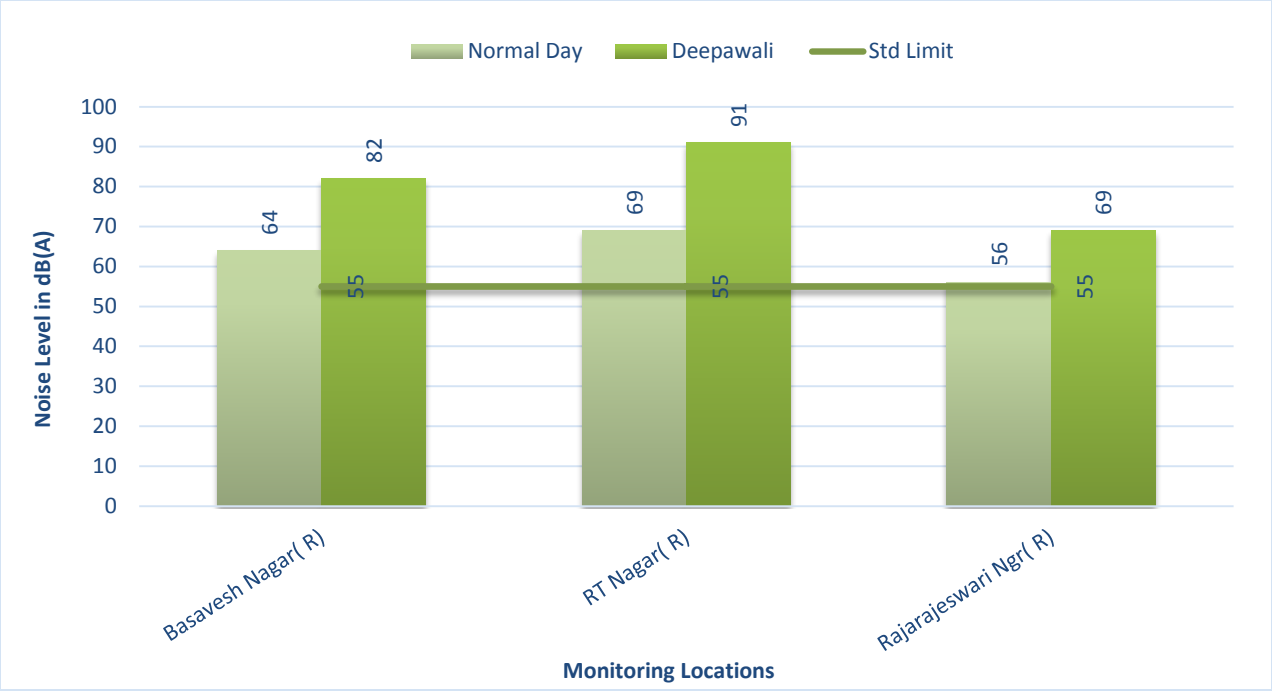


Figure 2: Ambient Noise level at various monitoring locations in Bengaluru

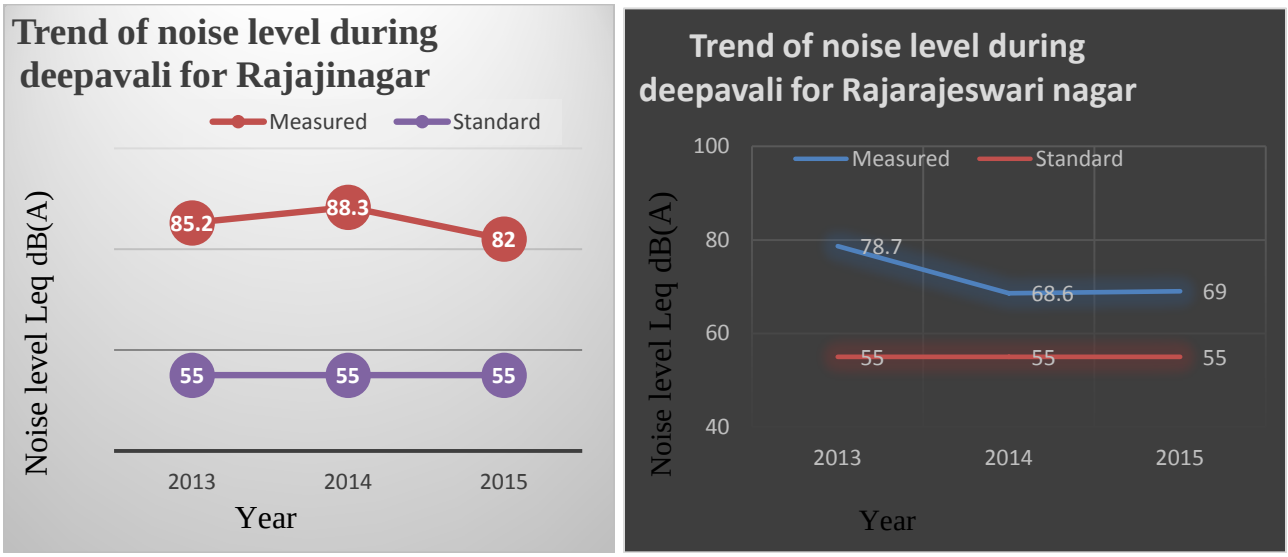


Figure-3: Trend of ambient Noise level during Deepavali

Similarly, the ambient noise level measured through online continuous ambient monitoring stations at 10 locations in Bengaluru are depicted in Table-3 and Figure-3.

Table 3: Trend of Real Time ambient Noise on Deepavali day

S.N	City	Stations	Ambient Noise level in Leq dB (A-24 hrs)					Trend
			2011	2012	2013	2014	2015	
1	Bangalore	Nisarga Bhawan	60	51	59	65.4	67	↑
2		Parisar bhawan	64	62	61	64.7	66	↑
3		BTM layout	65	63	62	68.7	68	↓
4		Marathahalli	57	55	61	65.6	62	↓
5		Peenya	59	57	56	63.5	63	↓
6		Yeswantpur	-	-	-	73.3	73	↓
7		Whitefield				75.4	66	↓
8		Domlur				74.7	70	↓
9		RVCE				61.5	62	↓
10		NIMHANS				71.6	66	↓

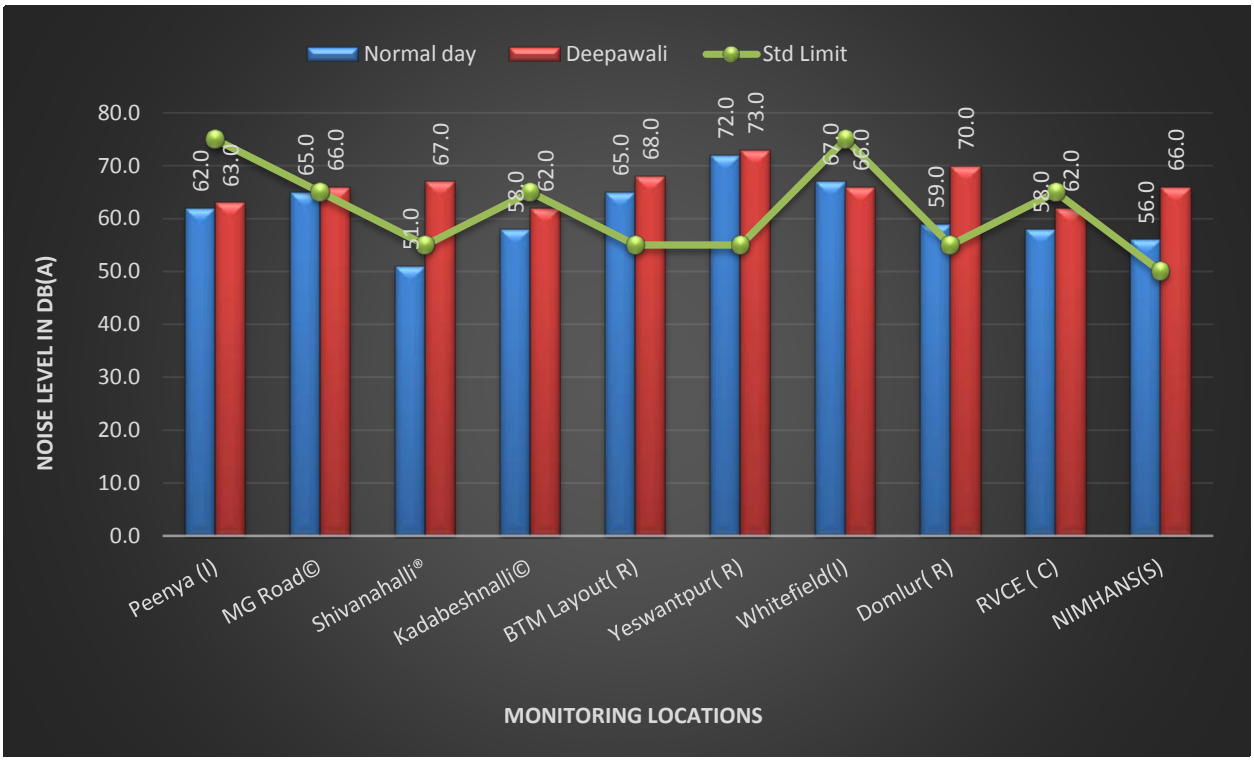


Figure-4 Online Ambient Noise Levels at Various locations in Bengaluru during Normal and Deepavali Day in November 2015

The noise level data measured at 4 residential locations through online continuous stations are ranging from 67 dB (A) to 73 dB (A) on deepavali day and exceeding the standard limit of 55 dB (A). The percentage of exceedance is ranged from 14.6% to 23.9%. The highest noise level 73 dB (A) recorded at Yeswanthpur and second highest is at Domlur 70 dB (A). However, the noise levels during normal day at these locations are within the prescribed limit. Similarly, the noise level measured at 2 industrial zones and 3 commercial zones are well within the prescribed limits both in normal and deepavali days. The noise level measured at NIMHANS in Silence zone is exceeding the standard limit and the percentage of violation during normal day is 6% and during deepavali day is 21% with respect to day time standard limit of 50 dB(A). The various parameters like minimum, maximum, percentiles measured hourly are separately tabulated and enclosed as **Annexure-I**.

E2. Ambient Air Quality Monitoring

Ambient air quality monitoring at various locations in Bengaluru during normal day on November 5th, 2015 and Deepavali day on November 11th, 2015 between 06.00 hrs. to next day 06.00 hrs. on 24 hourly basis were carried out. The instruments and methods used for monitoring and analysis for manual are given at Table-4. whereas the instrument used in the online measurement is EPA or equivalent approved.

Table-4: Instruments and methods used for ambient air monitoring and analysis

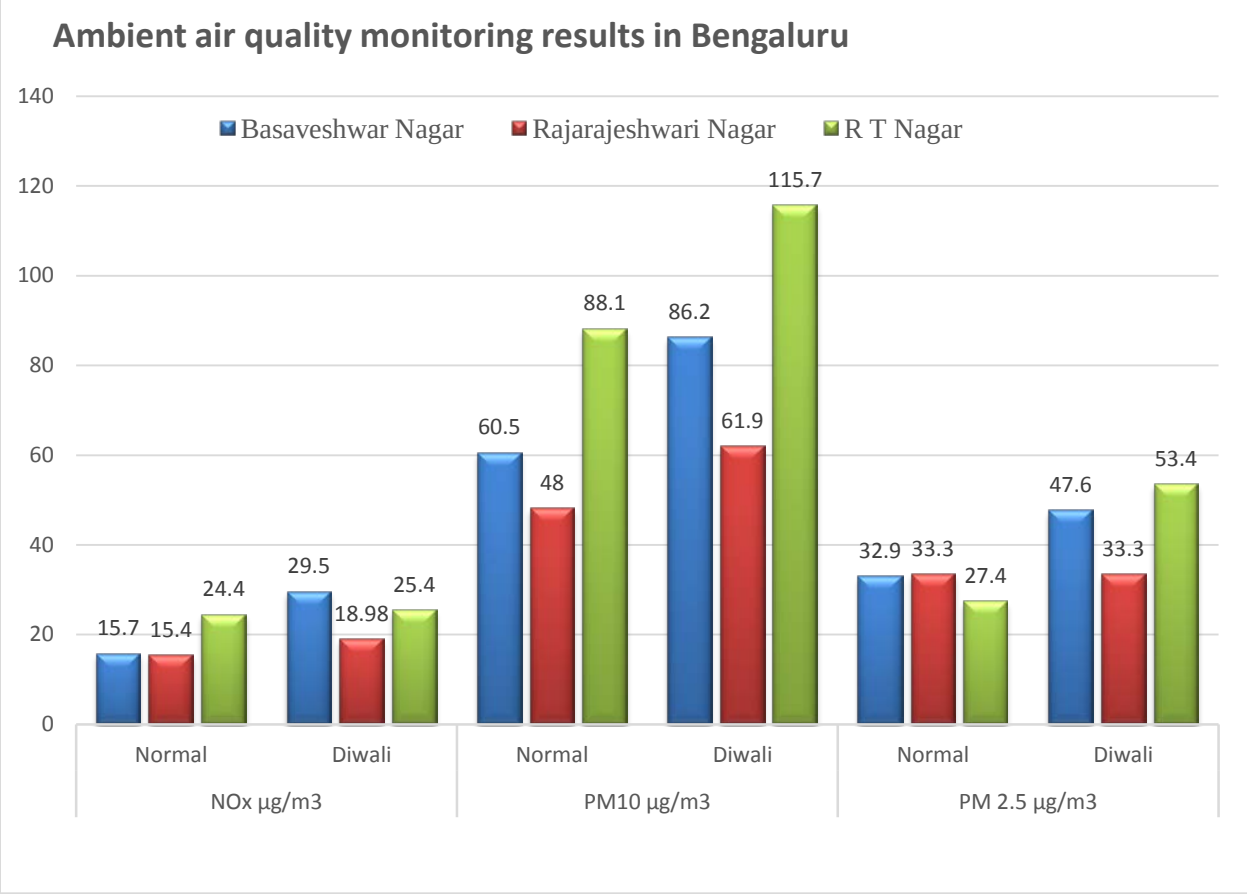
Parameter	**Equipment used for monitoring**	**Method of Measurement**	**Instrument used for analysis**
Respirable Suspended Particulate Matter (PM_{10})	Respirable Dust Sampler - APM 460NL	Gravimetric method	Mettler balance
$PM_{2.5}$	PM 2.5 sampler BGI make	Gravimetric method	Micro analytical balance
Sulphur Dioxide (SO_2)	Thermoelectrically cooled attachment or gas sampler	Improved West Gaeke method	Spectrophotometer
Nitrogen Dioxide (NO_x)		Modified Jacob & Hochheiser	

The 24 hourly average concentration during normal day and Deepavali day reveal that the concentration of Respirable Suspended Matter ($RSPM_{10}$) Sulphur Dioxide, Oxides of Nitrogen (NO_x) and PM2.5 are of below the standard limit. The data obtained from laboratory are depicted in Table 5 and 6

Table-5: Ambient Air Quality Monitoring Results in Bengaluru

Parameter→ **Location↓**	**SO_2 µg/m^3**		**NO_x µg/m^3**		**PM_{10} µg/m^3**		**PM 2.5 µg/m^3**	
	Normal	Deepavali	Normal	Deepavali	Normal	Deepavali	Normal	Deepavali
Basaveshwar Nagar	BDL	BDL	15.7	29.5	60.5	86.2	32.9	47.6
Rajarajeshwari Nagar	BDL	BDL	15.4	18.98	48	61.9	33.3	33.3
R T Nagar	BDL	BDL	24.4	25.4	88.1	**115.7**	27.4	53.4
Concentration range	BDL	BDL-9.75	BDL-52.5	9.98-38.8	42.5-98.3	34.8-227	27.4-33.3	33.3-53.4
Standard limit	**80**		**80**		**100**		**60**	

All values are expressed in 24 hourly basis (µg/m^3), BDL: PM10- 5 µg/m^3 ,SO_2: 4 µg/m^3, NO_x: 9 µg/m^3



The ambient air quality data recorded in the continuous ambient air quality monitoring stations operated at both Bengaluru and Chennai at six locations for the period from 05.11.2015 06.00hrs to 06.11.2015 06.00hrs on normal day & 11.11.2015 06.00hrs to 12.11.2015 06.00hrs is enclosed in **Annexure-2**

F. Observation on Meteorological Condition

The Meteorological data of 24 hourly average recorded in the continuous ambient air quality monitoring stations both Bengaluru and Chennai are depicted in table 6.

The table reveals that the minimum temperature recorded in Bengaluru is 26.8°C when the Relative humidity is 54.6% whereas in Chennai is 32.1°C at 47%. The average temperature recorded at Bengaluru is 26.8°C when the relative humidity is 79.6% and in Chennai 32.1°C while at 48.3% of humidity on normal day 05.11.2015.

Table 6: Meteorological data in CAAQMS

Cities	Stat	TEMP ^{0}C	RH %
Chennai	Min	26.1	47.0
05.11.2015	Max	33.7	90.4
	Average	32.1	48.3
Bengaluru	Min	24.6	54.6
05.11.2015	Max	30.5	95.3
	Average	26.8	79.6
Chennai	Min	24.81	72.98
11.11.2015	Max	32.93	90.39
	Average	27.64	74.78
Bengaluru	Min	23.55	83.04
11.11.2015	Max	26.92	95.28
	Average	24.98	87.26

The table also reveals that the minimum temperature recorded in Bengaluru is 23.6°C when the Relative humidity is 83.0% whereas in Chennai, temperature is 24.8°C at 73.0% of humidity. The average temperature recorded at Bengaluru is 25.0°C when the relative humidity is 87.36% and in Chennai 27.6°C while at 74.8% of humidity on Deepavali day 11.11.2015. The overall physical observation is that before and after the monitoring days, there was continuous

rain fall and during monitoring period atmosphere was cloudy. The weather was severely affected by cyclone effect.

G. Observations

- There was continuous rainfall in Bengaluru around Deepavali due to which there was a significant drop in bursting of crackers, hence noise level remarkably reduced in most of the areas. But by the evening of 11-11-2015, the rain reduced and bursting of fireworks was more as compared to other days.
- Due to rains and less vehicular traffic flow during Deepavali, the ambient air quality in respect of SO_2, NO_x and RSPM is similar to normal day.
- The ambient noise levels on Deepavali and as well as on normal day is not complying with the national ambient noise standards.
- Due to consistent persuasion and continuous public awareness created by CPCB and KSPCB to observe "Right to Sleep", the bursting of crackers was considerably reduced after 10:00 PM.
- The trend of noise level during Deepavali is decreasing in most of the areas. The percentage of Noise level exceedance during deepavali period is ranging from 18% to 60% and on normal day it is ranging from 1% to 7%.
- SO_2, NO_x and $PM_{2.5}$ values are within the National Ambient air quality standards at three locations where manual monitoring was conducted. On Deepavali day, PM_{10} in RT nagar was 116 µg/m^3 against the standard limit of 100 µg/m^3.

H. Recommendations

- The cumulative effort of the actions being taken by the society and regulatory authorities are to be further strengthened to reduce noise levels.

- The Resident Welfare Associations to hold community fireworks for brief period of 30 minutes on a single day and restrict window for use of fireworks to be from 7:00 p.m. to 9:00 p.m. so that much inconvenience is not caused to public.

- The noise standard for fire crackers notified by the Ministry of Environment, Forest and Climate Change vide GSR 682(E) dated October 5, 1999, and by the Hon'ble Supreme Court on 27.09.2001 should be strictly enforced by the implementing agencies.

- The order of the Hon'ble Supreme Court of India dt September 27, 2001 prohibiting the use of fire crackers between 10PM and 06 AM should be strictly enforced.

- Enforcing legal action on un-authorized manufacturing, storage and selling of fire crackers should be strictly ensured.

- Designated centralized places for sale and burning fire crackers shall be identified by the local authority.

- Notifying that the noise is cruelty to the animals generated by the fire crackers which may be incorporated under relevant Act and Rules.

- The local authority must take prior measures to handle excess garbage (solid waste) generated during Deepavali.

- Mass awareness programme through various media about the ill effects of the fire crackers shall be organized regularly.

- Collective participation of the community for bursting of crackers at playground, stadium and open places should be encouraged rather than bursting near individual houses and in thickly populated area.

- The manufacturer should print the composition of the cracker and noise levels likely to be produced on the carton so that public can be cautious at the time of purchase.

- There should be continuous education and awareness among the public and students rather than only during festival period. Awareness is to be created through mass media both in print and electronic media so as to educate the public to avoid bursting of crackers at any point of time.

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