Chapter-4
Ambient air quality in Gujarat

4.1 Framework to measure ambient air quality in the State

Ambient Air refers to any unconfined portion of the atmosphere or outdoor air. The respiratory air consists of Oxygen (20.95 *per cent*), Nitrogen (78.09 *per cent*) and Carbon Dioxide (0.04 *per cent*) and small amount of other gases. Air pollution occurs if there is a change in the composition of the ambient air. Generally, it is caused by smoke, dust, gases, fumes, aerosols, and odorous substances. CPCB has notified (November 2009) standards for 12 pollutants (PM_{10}, $PM_{2.5}$, Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Ammonia (NH_3), Ozone (O_3), Carbon Monoxide (CO), Lead (Pb), Arsenic (As), Nickel (Ni), Benzene (C_6H_6) and Benzo (a) pyrene ($C_{20}H_{12}$[1]) of Ambient Air Quality (AAQ). The concentration of PM_{10} and $PM_{2.5}$ in the ambient air is the major indicator of the quality of the air. As per the CPCB notification, annual average concentration of PM_{10} and $PM_{2.5}$ in ambient air should be 60 µg/$m^3$and 40 µg/m^3 respectively.

GPCB monitors (December 2020) AAQ in the State through 38 stations established under the National Air Quality Monitoring Programme[2] (NAMP) and 24 stations established under the State Air Quality Monitoring Programme[3] (SAMP). In addition to AAQ, the presence of Volatile Organic Compounds (VOC) was also being monitored at 25 stations out of these 62 stations in the State. The presence of metals in the ambient air was also being monitored at Alang and Sosiya ship-breaking yard, Bhavnagar.

For real-time monitoring of AAQ in the State, the CPCB has installed sensor-based Continuous Ambient Air Quality Monitoring Stations (CAAQMS) at six locations[4]. The Ahmedabad Municipal Corporation with the support of the SAFAR[5] has developed Air Information and Response Plan for Ahmedabad and established CAAQMS in and around Ahmedabad city for monitoring of AAQ and dissemination of information on the AAQ. AMC also issues health advisory to the residents of the Ahmedabad city.

4.2 Improving ambient air quality of the State

The GPCB publishes station-wise annual average of PM_{10} and $PM_{2.5}$, measured under NAMP and SAMP, in its Annual Reports. The concentration of PM_{10} and $PM_{2.5}$ in ambient air between 2011-12 and 2020-21 is as shown in **Table 5:**

1 It is one of the benzo-pyrenes formed due to incomplete combustion of organic matter.
2 CPCB is executing a nation-wide programme of AAQ monitoring. The network consists of 804 operating stations covering 344 cities/towns in 28 States and 6 Union Territories of the country.
3 Under the programme the GPCB is monitoring the ambient air quality in the State.
4 Gandhinagar, Vatva, Maninagar, Ankleshwar, Vapi and Jamnagar.
5 System of Air Quality and Weather Forecasting and Research, operated by Indian Institute of Tropical Meteorology, Pune, Ministry of Earth Science, GoI.

Table 5: - Concentration of PM_{10} and $PM_{2.5}$ (Annual Average) in the ambient Air

Year	Total monitoring stations	Concentration of PM_{10} in µg/ m^3 (Norm is 0-60 µg/m^3)					Concentration of $PM_{2.5}$ in µg/ m^3, (Norm is 0-40 µg/m^3)		
		0-60	61-99	100-150	151 - 200	201 and above	0-40	41-60	61-100
2011-12	41	02	29	10	-	-	25	09	07
2012-13	44	04	30	09	01	-	28	11	05
2013-14	43	-	31	12	-	-	42	01	-
2014-15	59	-	59	-	-	-	58	01	-
2015-16	62	-	46	16	-	-	62	-	-
2016-17	62	-	12	50	-	-	62	-	-
2017-18	62	-	01	37	24	-	12	49	01
2018-19	62	-	-	08	27	27	02	28	32
2019-20	62	-	09	53	-	-	54	8	-
2020-21	62	-	29	33	-	-	56	6	-

(Source: - Annual Reports of the GPCB for the years 2011-12 to 2020-21)

- In 2011-12, out of 41 stations, at two stations[6], concentration of PM_{10} was within the norm of 60 µg/m^3 while at 39 stations it ranged between 61 and 150 µg/m^3. However, during 2013-14 to 2020-21, at none of the stations, the concentration of PM_{10} was within the norms. In 2018-19, the concentration of PM_{10} at 27 out of 62 stations was observed even above 200 µg/ m^3.

- In 2011-12, at 25 out of 41 stations, concentration of $PM_{2.5}$ was within the norms. During 2015-17, at all the 62 stations, concentration of $PM_{2.5}$ was within the norms. However, in 2018-19 concentration of $PM_{2.5,}$ was within the norms at only two stations and at 32 stations, it was above 60 µg/m^3.

  Thus, during the period between 2011-12 and 2018-19, concentration of two major air pollutants PM_{10} and $PM_{2.5}$ had increased indicating substantial deterioration of the AAQ in the State. GPCB stated (December 2019) that Gujarat is a semi-arid region and due to moderate to high wind velocity, air-borne dust remains in suspension for very long time causing increased concentration of PM_{10}. Other factors such as rapid urbanization, industrial growth and increase in numbers of vehicles contributed to escalation in concentration of PM_{10}.

- In 2019-20 and 2020-21, at none of the stations, the concentration of PM_{10} was above 150 µg/m^3. Also, at none of the monitoring stations the concentration of $PM_{2.5}$ was above 60 µg/m^3 during the same period. Thus, in 2019-21, overall ambient air quality had improved in comparison to 2017-18.

[6] GPCB office premises at Vadodara and LD Engineering College, Ahmedabad.

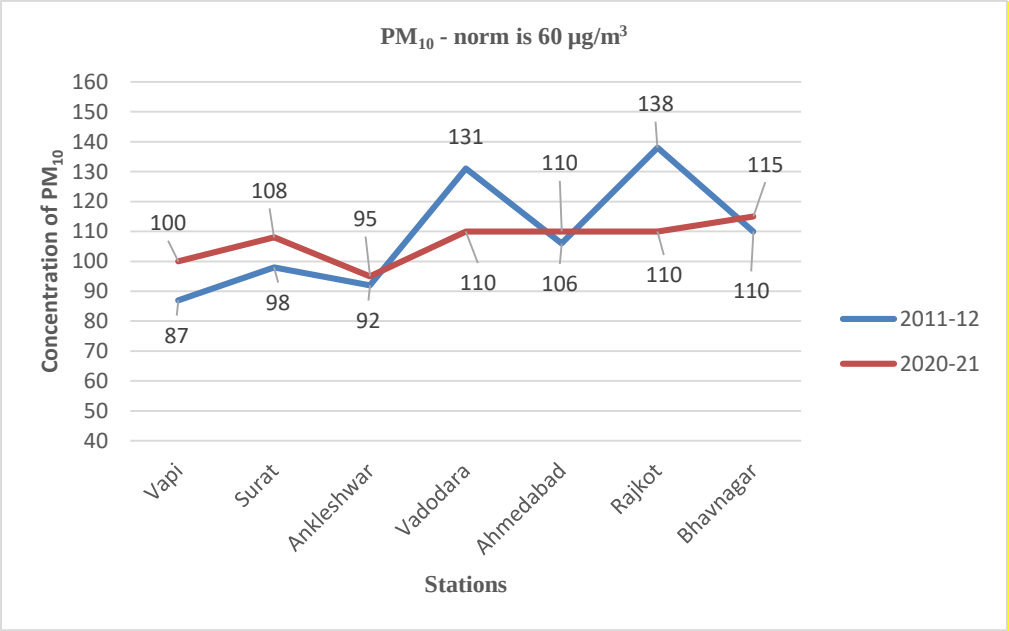
- Comparison of 2020-21 data with 2011-12 reveals that concentration of PM_{10} worsened as in more than 50 *per cent* stations (33 out of 62), concentration was more than 99 µg/m^3 in 2020-21 compared to about 25 *per cent* (10 out of 41) in the year 2011-12. Concentration of $PM_{2.5}$ had improved during the period as in more than 90 *per cent* (56 out of 62) stations, concentration did not exceed 40 µg/m^3 in 2020-21 compared to about 60 *per cent* (25 out of 41) in 2011-12.

The GPCB may continue making efforts towards improving ambient air quality by monitoring the concentration of PM_{10} and $PM_{2.5}$ particularly with special focus on PM_{10} as even in 2020-21 concentration was more than 99 µg/m^3 in 33 out of 62 stations.

4.2.1 Concentration of PM_{10} and $PM_{2.5}$ in selected highly polluting stations

Audit reviewed the concentration level of PM_{10} and $PM_{2.5}$ in seven highly polluting stations out of 41 stations. A comparison of the concentration level of PM_{10} and $PM_{2.5}$ measured at seven stations[7] during 2011-12 vis-à-vis 2020-21 is shown in Graph 1 and Graph 2 below.

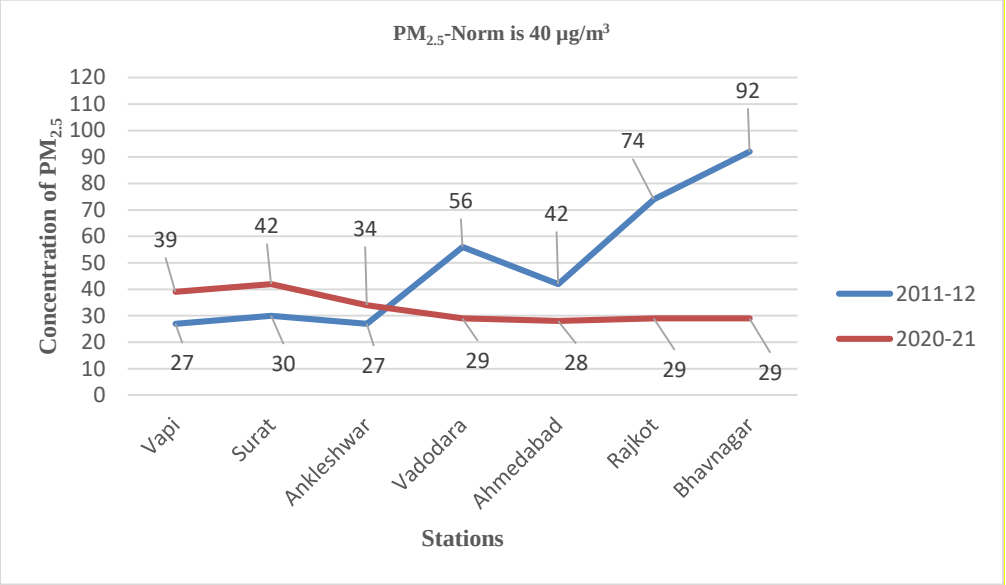
Graph 1



From the above Graph, it may be seen that out of the seven stations, the annual average concentration level of PM_{10} increased at five stations (Vapi, Surat, Ankleshwar, Ahmedabad and Bhavnagar) in 2020-21 as compared to 2011-12 and was above the norm of 60 µg/m^3. At two stations (Vadodara and Rajkot), though the concentration level decreased it continued to remain above 60 µg/m^3.

[7] **Stations:** (i) GEB GIDC Club 3 Building, Vapi, (ii) B.R.C. High School, Udhna, Surat, (iii) Rallis India, Ankleshwar, (iv) GIDC Nandesari, Vadodara, (v) Naroda GIDC, Ahmedabad, (vi) Near Sardhara Corporation, Rajkot and (vii) Chitra GIDC Bhavnagar.

Graph 2



As regards the annual average concentration level of $PM_{2.5}$, it may be seen from the above Graph that though it increased at three stations (Vapi, Surat and Ankleshwar) in 2020-21 compared to 2011-12, the same remained within the norm of 40 µg/m^3 at two stations viz., Vapi and Ankleshwar. The concentration level of $PM_{2.5}$ decreased significantly at other four stations (Vadodara, Ahmedabad, Rajkot and Bhavnagar) and were within the norms.

It could be seen from the above that the concentration level of PM_{10} in the selected stations continued to remain above the norm of 60 µg/m^3 while the concentration level of $PM_{2.5}$ has come down within the norm of 40 µg/m^3. This indicates that GPCB may have to take effective measures to improve ambient air quality particularly PM_{10} which is major contributor in deterioration of the air quality in the vicinity of these stations.

4.3 Insufficient monitoring of ambient air quality and noise emissions

Under section 16 of the Air Act 1981, the CPCB notified (November 2009)[8] National Ambient Air Quality Standards (NAAQS) for 12 pollutants. Standards of these pollutants were different for Industrial, Residential, Rural and Other Areas and Ecologically sensitive areas (notified by GOI).

As per NAAQS, the concentration of two pollutants (Ozone and Carbon Monoxide) in ambient air at a particular site is to be measured every eight hours, the concentration of six pollutants (SO_2, NO_2, PM_{10}, $PM_{2.5}$, Pb and NH_3) is to be measured twice a week at uniform intervals[9] and concentration of remaining four pollutants (Benzene, Benzo (a) pyrene, Arsenic and Nickel) is to be measured on an annual basis.

[8] Earlier to this, old standards notified in April 1994 were in force.
[9] Sampling duration is 24 hours.

Further, the Ministry had set Ambient Air Quality Standards in respect of noise for industrial, commercial, residential areas, and silence zone[10] under the Noise Pollution (Regulation and Control) Rules, 2000. Every unit must comply with these AAQ standards and take adequate measures to control pollutants and noise levels[11] within the premises.

Audit observed that:

- In all the test checked cases, the CCAs accorded by the GPCB included conditions relating to monitoring of AAQ as per the notification *ibid* but it was restricted to monitoring of only four pollutants (PM_{10}, $PM_{2.5}$, NO_2 and SO_2) instead of twelve pollutants.
- During 2014-19, the GPCB measured AAQ in only 10 out of 55 highly polluting units test checked in audit.
- In all the test checked cases, the Inspection reports of the GPCB showed that it did not regularly monitor noise levels during 2014-19 in the premises of the industrial units.

Thus, the only source of the AAQ data in the State is the information collected at 62 stations under the NAMP and SAMP. Audit is of the view that in the absence of monitoring of concentration of pollutants in ambient air in the premises of a unit, compliance with AAQ standards cannot be ensured. As a result, the quantity and quality of air pollutants attributed to any activity in areas not covered under NAMP and SAMP were not available with the GPCB.

Government stated (January 2022) that major industries are regularly monitoring AAQ in their premises as a part of the self-monitoring mechanism. Government further stated that AAQ is a time taking exercise and its regular monitoring in every major industrial area and units by GPCB is not feasible due to shortage of manpower. The Government has been apprised about the shortage of human resources in the GPCB.

Regarding monitoring of four pollutants instead of 12, Government stated (January 2022) that as all parameters were not relevant to each and every type of industrial unit, the applicable parameters for major industrial types would be decided and where required CCA would be amended to make it in consonance with the notified parameters.

The reply is not convincing as GPCB was required to monitor all 12 pollutants as per the CPCB's notification of November 2009.

The GoG may strengthen the human resources of GPCB to monitor all 12 pollutants.

[10] Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places, or any other area which is declared as such by the competent authority.

[11] For industrial areas, the noise level is 75 dB (A) during daytime (10 am to 06 pm) and 70 dB (A) in the night (06 pm to 10 am).

4.4 Non-inclusion of all areas for monitoring of ambient air quality

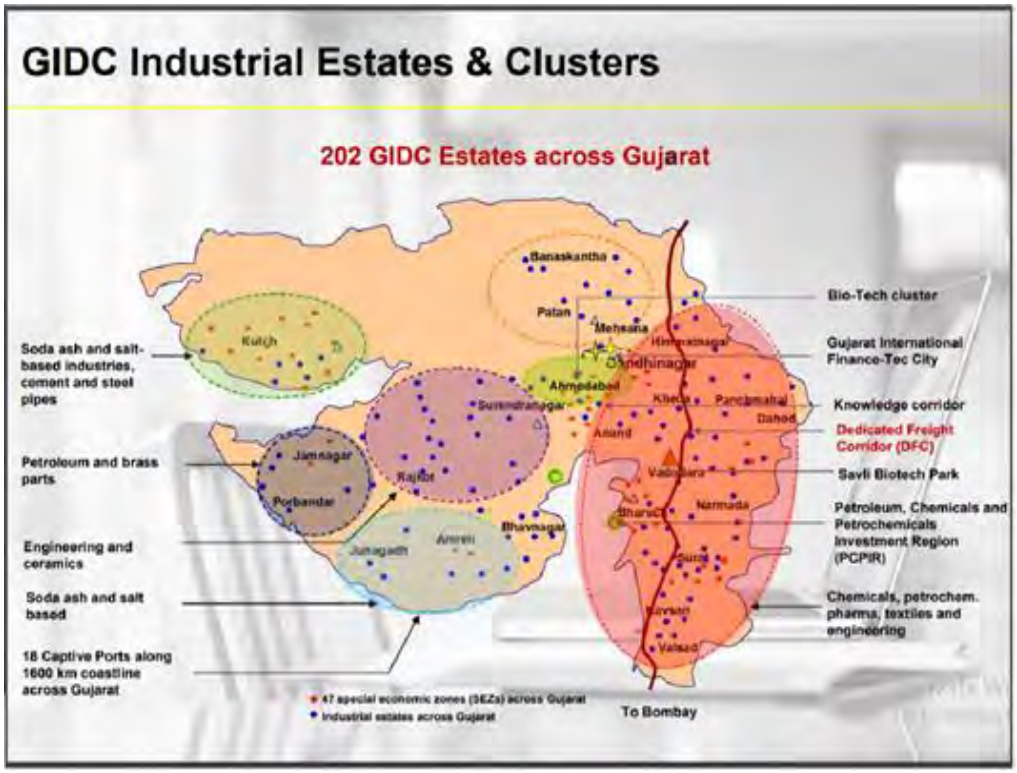
For designing interventions for the control of air pollution, GPCB must have a comprehensive database of all the potential polluting areas of the State. GPCB monitors (November 2021) AAQ at 62 stations in 14 cities only whereas in the remaining cities, industrial and mining areas, the AAQ is not being monitored.

In Gujarat, there are 202 industrial estates administered by the Gujarat Industrial Development Corporation (GIDC). In addition, there are private industrial estates in the State located within or near the cities. All these estates have industries of different categories and contribute significantly to escalation of PM_{10}, $PM_{2.5}$ and other air pollutants. Besides, clusters *viz*. Vatrak (Dhansura), Chitrasani, Bagasara, Sayla, Ambaji, Sevaliya, Panandhro, Chikhali, Pardi and lignite mines in Kachchh and Surat where mining and stone crushing units[12] have significant presence, are major sources of fugitive emissions (Solid Particulate Matter, SPM).

The Map alongside is showing 14 locations of 62 monitoring stations.

Audit observed that AAQ was not being monitored in some of the major industrial estates in the State such as Viramgam, Dhandhuka, Mandal, Vallabh Vidyanagar, Waghodia, Halol, Ranoli, Vagara, Bardoli, Chhatral, Kalol, Dediyasan, Dahod, Porbandar, Sanand, Surendranagar, *etc.* The Map below is showing major industrial estates and clusters in the state.

[12] As per the data base of the GPCB, number of stone crushers in Gujarat as of November 2021 were 1,681 and total pollution score of stone crusher activity on account of Air pollution is 50.



Disclaimer: Both the Maps are for indicative purpose

Further, in the areas where the stone crusher units are located, the concentration of SPM was not being monitored.

GPCB had proposed (January 2017) to establish 20 additional AAQ monitoring stations under NAMP of which CPCB approved only 13 stations, for which tendering was in process (January 2022). GPCB stated (June 2021) that the instructions had been issued (June 2021) to the ROs to monitor AAQ in the areas which had not been covered under NAMP and SAMP. Though, the process to establish more stations has been initiated, the collection and compilation of data pertaining to air quality that impacts human health and actions to raise awareness about dangers in the air have not been prioritised.

GPCB may expedite establishment of AAQ monitoring stations in areas not covered under existing monitoring system and regularly monitor the ambient air quality in other areas.

GPCB may take up issue of setting up of AAQ monitoring stations in the industrial estates with GIDC. Further, GPCB may persuade GIDC to provide capital assistance for setting up of AAQ monitoring stations similar to assistance provided for setting up of common effluent treatment plants and common incineration plants.

4.5 Increased concentration level of volatile organic compounds

Volatile Organic Compounds (VOC) are organic chemical compounds that evaporate under normal atmospheric conditions of temperature and pressure. The combustion and distribution of petroleum products, containing traces of Benzene, Toluene and Xylene (BTX), are the main outdoor source of the VOC emissions.

Gujarat is a major transitional point for cargo movement due to major ports in the state and industrial development. With 2.52 crore registered vehicles and 4,575 fuel retail outlets, total petroleum consumption in Gujarat in 2019-20 was 10.52 *per cent* of the total consumption of India. Thus, the State is more prone to VOC-induced air pollution.

GPCB collects data of concentration of 16 parameters of VOC at 25 stations in a month. The change in annual average concentration[13] of five main components of VOC (Benzene, Toluene, p-xylene, m-xylene, and o-xylene) in Gujarat during the period 2014-15 to 2019-20 is shown in **Table 6** below: -

Table 6: - Trends of concentration of VOC (in µg/m^3)

Annual Average	Benzene	Toluene	p-xylene	m-xylene	o-xylene
2014-15	3.04	4.50	3.22	3.12	2.48
2019-20	4.52	4.05	2.40	2.40	2.96
2020-21	4.22	3.95	2.48	2.47	2.59
Percentage change from 2014-15 to 2019-20	(+) 48.82	(-) 10.08	(-) 25.37	(-) 23.08	(+) 19.39
Percentage change from 2014-15 to 2020-21	(+) 38.82	(-) 12.22	(-) 22.98	(-) 20.83	(+) 4.44

(Source: - Annual Reports of GPCB)

It can be seen from the table that from 2014-15 to 2019-20, concentration of Benzene and o-xylene had increased significantly. However, in 2020-21, the concentration had reduced marginally mainly due to slow down of industrial activities during the COVID-19 pandemic. VOC levels lead to formation of ground-level ozone. The exposure to high levels of Benzene and o-xylene causes neuro-toxic symptoms and persistent exposure to these compounds may cause injury to human bone marrow, DNA damage in mammalian cells and damage to the immune system. Though GPCB collects the data of concentration level of VOC at 25 stations, it does not analyse or monitor it for taking appropriate measures to control VOC-induced emission.

GPCB stated (April 2020) that norms for all VOC were not prescribed in NAAQM 2009 except for Benzene and Benzo (a) Pyrene which was within the permissible limit. It was further stated that the data in respect of 16 parameters of VOC was being collected from 25 stations for future planning.

Audit is of view that GPCB should monitor concentration level of VOC at all 62 stations. Based on the analysis of this data, GPCB should design and implement mitigation measures to control the VOC-induced emission.

4.6 Variation between SAMP and CAAQMS monitoring data

The reliability of data is a prerequisite of an effective regulatory mechanism. To monitor all the 12 parameters of AAQ in addition to VOC and weather data continuously, the GPCB has installed sensor-based Continuous Ambient Air Quality Monitoring Stations (CAAQMS) at Maninagar and Vatva in Ahmedabad, Ankleshwar, Vapi, Gandhinagar and Jamnagar and linked them with the server of the GPCB and CPCB.

[13] Based on data of 16 components of VOC at 25 stations in Gujarat collected by the GPCB.

Audit noticed (September 2019) that at Vatva CAAQM station, manual monitoring of AAQ was also being done under SAMP. Audit compared the sensor-based data of six major parameters of AAQ with the manual data on nine different days as shown in **Table 7** below:

Table: 7 - Manual (SAMP) and Sensor (CAAQMS) base data in $\mu g/m^3$

Date	Souse of data	SO_2	NOx	NH_3	PM_{10}	$PM_{2.5}$	Benzene
03.05.19	CAAQMS	12.32	127.49	82.50	144.97	55.00	0.31
	SAMP	27.4	35.0	<20	137	36	1.89
07.05.19	CAAQMS	30.09	114.90	69.38	134.26	56.17	1.47
	SAMP	46.0	42.6	< 20	149	42	2.14
10.05.19	CAAQMS	40.12	184.18	107.66	93.31	37.18	8.08
	SAMP	19.8	30.2	< 20	116	33	1.36
14.05.19	CAAQMS	32.81	146.99	85.46	122.08	45.04	7.80
	SAMP	19.0	30.8	< 20	122	28	1.24
17.05.19	CAAQMS	33.34	118.05	76.97	116.27	41.40	4.68
	SAMP	21.0	23.9	< 20	112	33	2.41
21.05.19	CAAQMS	75.30	111.70	9.71	106.55	45.54	6.06
	SAMP	20.6	38.5	< 20	117	26	1.62
24.05.19	CAAQMS	142.18	129.34	6.18	147.91	60.83	4.92
	SAMP	21.3	37.4	<20	111	24	1.47
28.05.19	CAAQMS	96.89	113.35	11.17	145.16	61.90	7.69
	SAMP	19.7	28.8	< 20	106	19	1.22
31.05.19	CAAQMS	103.32	107.46	17.36	129.13	59.19	5.83
	SAMP	22.9	34.9	< 20	121	31	2.36

(Source: CAAQMS and SAMP data at Vatva)

It can be seen from the above table that there was large variance between sensor-based data and manual data. The sensor-based data were very high compared to manual data for SO_2, NOx, $PM_{2.5}$ and Benzene on most of the days. Audit is of the view that since manual, as well as sensor-based monitoring, were being done at the same station, the data (24 hours' average) on any day of sampling should have been identical. No reasons for variance in monitoring data were available on record.

GPCB stated (April 2021) that CAAQMS results were based on continuous monitoring and analysed by sensor-based instruments while in SAMP stations, samples were collected on an interval ranging from one hour to eight hours. Government further stated (January 2022) that reasons for variation were being analysed by the Technical Committee of GPCB.

Audit recommends that there is a need to analyse and reconcile the wide variation between manual and sensor-based data so that quality of data used for monitoring air quality is improved.

Conclusion

Rapid urbanization, industrial growth, and increasing density of vehicles on road are contributing to the increased concentration of PM_{10} and $PM_{2.5}$. AAQ was not being measured in major industrial estates and other areas in the State. No new AAQM station has been set up since 2015-16. The GPCB has not created facilities at diverse locations to collect more comprehensive data on AAQ of the State which is necessary for designing interventions to mitigate the impact of air pollution and to improve the ambient air quality.