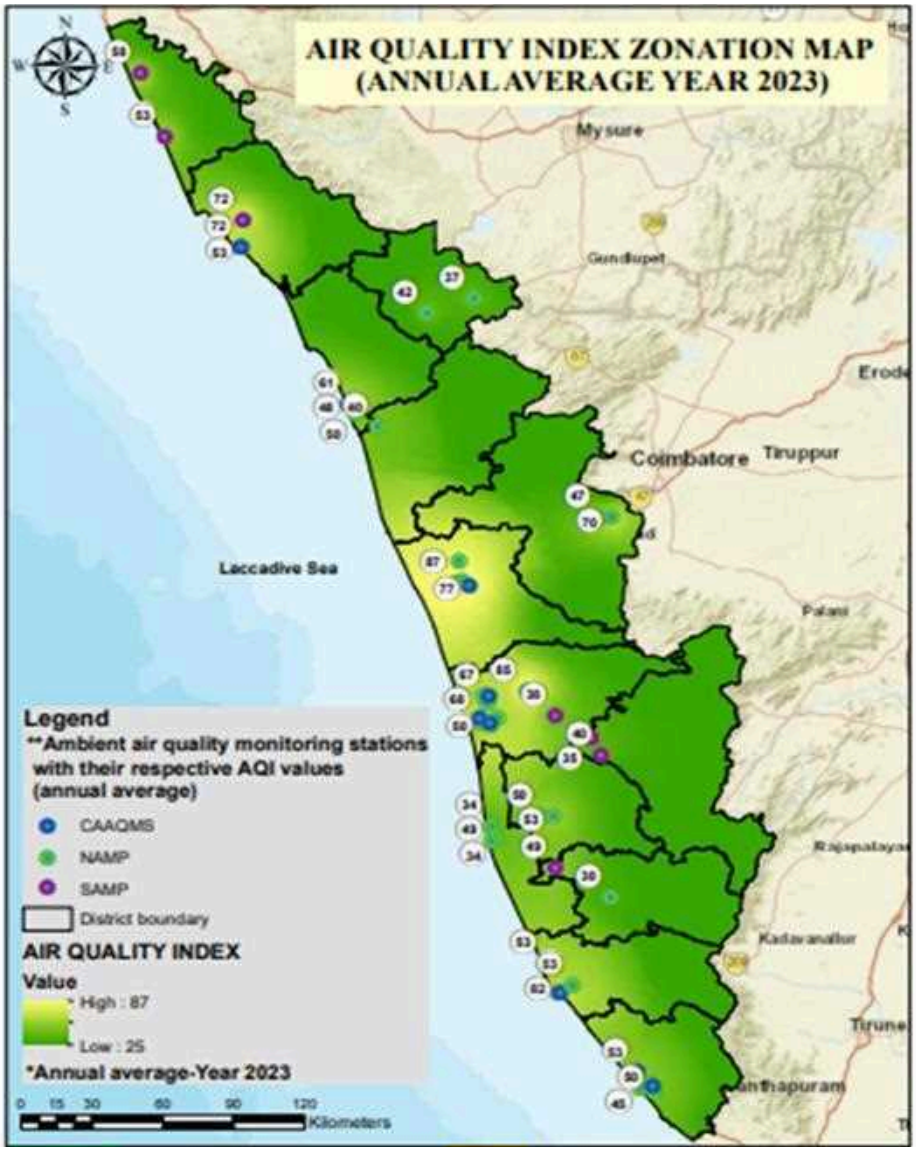
AIR QUALITY STATUS REPORT



Executive Summary

Air pollution is a persistent and established public health problem. Local emissions from multiple sources like vehicles, road dust, industries, household activities, wastes burning, emissions from legacy waste dump sites and burning of agricultural residue are major sources of pollution from anthropogenic sources. Air pollution emission issues are associated with many sectors, which inter-alia includes power, transport, industry, construction, agriculture and waste management etc. Thus, there is a need for regional-level initiatives through inter-state and inter-city coordination in addition to multi-sectoral synchronization.

The Ministry of Environment, Forest and Climate Change, Government of India has launched National Clean Air Programme (NCAP) in January, 2019 as a long-term, time-bound, national level strategy to tackle the air pollution problem across the country in a comprehensive manner. Altogether 132 cities together with a million plus population have been identified as non-attainment cities so far by the Central Pollution Control Board (CPCB). In Kerala, there are no non-attainment cities. The original application No. OA 159 of 2021 was filed before the Hon'ble NGT regarding the implementation of National Clean Air Programme.The Hon'ble NGT in its order dated 20.01.2023 Suo Moto impleded the State of Kerala as respondent.

Accordingly, the State Action Plan was submitted to the Central Pollution Control Board on 02.11.2023 and further modified SAP was submitted on 19.01.2024. Subsequently, NGT directed the Central Pollution Control Board to issue common guidelines for preparation of the State Action Plan. As per the new guidelines, an Air Quality Monitoring Committee (AQMC) chaired by the Principal Secretary, Environment Department and Steering committee chaired by the Chief Secretary have been constituted by the State of Kerala as per Government Order dated 26.10.2024. Draft action plan is now under the consideration of AQMC and the Steering Committee. Action plan will be implemented so as to achieve interim targets as per plan to have air quality as per NAAQS.

1. INTRODUCTION AND BACKGROUND

Air pollution is a persistent and established public health problem. Local emissions from multiple sources like vehicles, road dust, industries, household activities, wastes burning, emissions from legacy waste dump sites and burning of agricultural residue are major sources of pollution from anthropogenic sources. The natural causes of air pollution are smoke from wildfires, ash from volcanoes and windblown sand or dust etc. The topography, land use, energy sources, mode of transportation etc along with meteorological factors influence the air quality of a particular area. Studies suggest that city level air quality is affected by both regional and background contributions. Air pollution emission issues are associated with many sectors, which inter-alia includes power, transport, industry, construction, agriculture,. Waste management etc. Air pollution impacts places away from the source also. Thus, there is need for regional-level initiatives through inter-state and inter-city coordination in addition to multi-sectoral synchronization.

1.1. O.A. no. 159/2021 :

The Original Application no. O.A. 159 of 2021 was filed by Kanaka Das, Kolkata before the Hon'ble NGT regarding the implementation of National Clean Air Programme (NCAP) which was launched by MoEF&CC in 2019, in the States of Telangana, Tamilnadu & Karnataka. The Hon'ble NGT had Suo Moto impleaded the State of Kerala as respondent as per the order dated 20.01.2023, in O.A. no. 159/2021.

As per the Order dated 15.03.2023 in O.A. No. 159/2021, the Hon'ble NGT has directed that a State Action Plan (SAP) on air pollution shall be prepared and forwarded to the Central Pollution Control Board (CPCB). The CPCB had provided a template for the SAP. The same was circulated among the departments concerned and the draft SAP was forwarded to CPCB by the Environment Department on 13.04.2023. As per the suggestions received from CPCB, the SAP was further revised. In the Order dated 17.10.2023 the Hon'ble NGT in OA 159/2021, it was directed to file response on the observations of CPCB. Accordingly, the updated SAP of Kerala was forwarded to CPCB on 02.11.2023. As per mail dated 12.12.2023, CPCB had made certain

observations in the revised SAP of Kerala. The SAP modified based on the said observations was forwarded to CPCB on 19.01.2024.

As per the NGT Order dated 09.05.2024, CPCB had issued common guidelines for preparation of the State Action Plan (SAP) based on the indicative template shared by the MoEF&CC. As per the Hon'ble NGT Order dated 03.09.2024, SPCBs were directed to give the response to the common guidelines issued by CPCB. The State Action Plan of Kerala revised as per the common guidelines of CPCB was submitted to CPCB vide letter dated 19.09.2024.

As per the common guidelines of CPCB, an Air Quality Monitoring Committee (AQMC) under the Chair of the Principal Secretary, Environment Department shall be constituted for the preparation of the SAP and the SAP shall be approved by a Steering Committee under the Chair of the Chief Secretary. Accordingly, the AQMC and Steering Committee were constituted as per G.O. (Rt) No. 84/2024/ENVT dated 26.10.2024. AQMC shall monitor the implementation of the SAP and report to the Steering Committee which shall periodically review the progress of implementation and give necessary guidance to the AQMC.

Members of **Steering Committee**:

1. The Chief Secretary, Kerala.
2. The Secretary to Government, Environment Department.
3. The Secretary to Government, Finance Department.
4. The Secretary to Government, Industries Department.
5. The Secretary to Government, Transport Department.
6. The Secretary to Government, Local Self Government Department.
7. The Secretary to Government, Public Works Department.
8. The Secretary to Government, Agriculture Department.
9. The Chairman, Kerala State Pollution Control Board.

Members of **Air Quality Monitoring Committee (AQMC)** :

1. The Secretary to Government, Environment Department.
2. The Director, Directorate of Environment and Climate Change.
3. The Director, Directorate of Industries and Commerce.
4. The Transport Commissioner, Motor Vehicles Department.
5. The Director, Road Safety Authority.
6. The Chairman / Managing Director, Kerala State Road Transport Corporation.
7. The Director, National Transportation Planning and Research Centre.
8. The Principal Director, LSGD Principal Directorate.
9. The Director, Urban Directorate.
10. The Director, Directorate of Panchayat.
11. The Executive Director, Suchitwa Mission.
12. The Director, Agriculture and Farmers welfare Department.
13. The Chief Engineer, Public Works Department.
14. The Chairman/ Managing Director, Kerala State Electricity Board.
15. The Chief Executive Officer, Agency for New and Renewable Energy.
16. The Director, Energy Management Centre.
17. The Member Secretary, Kerala State Pollution Control Board.

1.2. National Clean Air Programme (NCAP):

The Ministry of Environment, Forest and Climate Change, Government of India has launched National Clean Air Programme (NCAP) in January, 2019 as a long-term, time-bound, national level strategy to tackle the air pollution problem across the country in a comprehensive manner. The NCAP targets to achieve 40% reduction in concentrations of PM10 (particulate matter of diameter between 10 and 2.5 micrometre) and PM2.5 (particulate matter of diameter

2.5 micrometre or less) by the year 2025-26, keeping 2017 as the base year for comparison of concentration by developing and implementing the action plans in the non-attainment cities.

Central Pollution Control Board (CPCB) identified 94 non-attainment cities (NAC) while circulating the draft NCAP in 2018 that was revised to 102 NAC's in January 2019. Two more were added to the list in 2020, taking the total to 124. Altogether there are 132 cities with a million plus population. The list of cities under NCAP focus now stands at 132 cities in 2021 with a million-plus population.

Non-attainment cities (NAC) :

Cities are declared non-attainment if over a 5-year period they consistently do not meet the National Ambient Air Quality Standards (NAAQS) for PM 10 (Particulate matter that is 10 microns or less in diameter) or N02 (Nitrogen Dioxide).

The aims of the NCAP are:

1. To ensure stringent implementation of mitigation measures for prevention, control and abatement of air pollution.
2. To augment and evolve effective and proficient ambient air quality monitoring network across the country for ensuring a comprehensive and reliable database.
3. To augment public awareness and capacity-building measures encompassing data dissemination and public outreach programmes for inclusive public participation and for ensuring trained manpower and infrastructure on air pollution.

In Kerala, no cities/towns are included in the above non-attainment cities.

1.3. National Ambient Air Quality Standards (NAAQS):

NAAQS are the standards for air quality that are set by the Central Pollution Control Board that are applicable all over the country as per the Air (Prevention and Control of Pollution) Act, 1981.

- These standards are essential for the development of effective management of ambient air quality.
- The first ambient air quality standards were developed in 1982 pursuant to the Air Act.

- Later, in 1994 and 1998, these standards were revised. The latest revision to the NAAQS was done in 2009 and this is the latest version being followed.
- The 2009 standards further lowered the maximum permissible limits for pollutants and made the standards uniform across the nation. Previously, industrial zones had less stringent standards as compared to residential areas.
- The compliance of the NAAQS is monitored under the National Air Quality Monitoring Programme (NAMP). NAMP is implemented by the CPCB.

The objectives of air quality standards are:

- To indicate the levels of air quality necessary with an adequate margin of safety to protect the public health, vegetation and property;
- To assist in establishing priorities for abatement and control of pollutant level;
- To provide uniform yardstick for assessing air quality at national level;
- To indicate the need and extent of monitoring programme.

Revised National Ambient Air Quality Standards (NAAQS)

[NAAQS Notification dated 18th November, 2009]

S. No.	Pollutants	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
			Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (notified by Central Government)	
1	Sulphur Dioxide (SO_2), µg/m^3	Annual*	50	20	1. Improved West and Gaeke 2. Ultraviolet Fluorescence
		24 Hours**	80	80	
2	Nitrogen Dioxide (NO_2), µg/m^3	Annual*	40	30	1. Modified Jacob & Hochheiser 2. Chemiluminescence
		24 Hours**	80	80	
3	Particulate Matter (Size <10µm) or PM_{10} µg/m^3	Annual*	60	60	1. Gravimetric 2. TEOM 3. Beta attenuation
		24 Hours**	100	100	
4	Particulate Matter (Size <2.5 µm) or $PM_{2.5}$ µg/m^3	Annual*	40	40	1. Gravimetric 2. TEOM 3. Beta attenuation
		24 Hours **	60	60	
5	Ozone (O_3), µg/m^3	8 hours**	100	100	1. UV photometric 2. Chemiluminescence 3. Chemical Method
		1 hours **	180	180	
6	Lead (Pb), µg/m^3	Annual *	0.50	0.50	1. AAS/ICP Method after sampling using EPM 2000 or equivalent filter paper 2. ED-XRF using Teflon filter
		24 Hour**	1.0	1.0	
7	Carbon Monoxide (CO), mg/m^3	8 Hours **	02	02	Non dispersive Infra Red (NDIR) Spectroscopy
		1 Hour**	04	04	
8	Ammonia (NH_3), µg/m^3	Annual*	100	100	1. Chemiluminescence 2. Indophernol blue method
		24 Hour**	400	400	
9	Benzene (C_6H_6), µg/m^3	Annual *	05	05	1. Gas chromatography based continuous analyzer 2. Adsorption and Desorption followed by GC analysis
10	Benzo(a)Pyrene (BaP)-particulate phase only, ng/m^3	Annual*	01	01	Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As), ng/m^3	Annual*	06	06	AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni), ng/m^3	Annual*	20	20	AAS/ICP method after sampling on EPM 2000 or equivalent filter paper

** Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform interval.** 24 hourly 08 hourly or 01 hourly monitored values, as applicable shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.*

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

1.4. Graded Response Action Plan (GRAP) :

GRAP is a set of emergency action plan implemented in four stages depending on the severity of the air pollution which is determined by the air quality index (AQI). Air Quality Index is a numerical scale that measures the level of air pollutants in a given area. It quantifies the concentration of major air pollutants, Particulate Matter(PM 10, PM 2.5), NOx, SO2. If the index is $\leq$ 50 then good quality, 51-100 satisfactory 101-200 Moderate, 201-300 poor, 301-400 very poor, 401-500 severe.

- The first stage of GRAP is imposed when the overall air quality is in the ‘poor’ category. Under this stage, the government imposes a heavy fine on garbage burning and sweeping without sprinkling water, ensuring proper implementation of guidelines on dust mitigation measures, ensuring regular lifting of municipal solid waste, construction and demolition waste, and hazardous wastes from dedicated dumping sites, and enforcing guidelines for use of anti-smog guns at construction sites.

- The second stage of GRAP is imposed when the air quality enters the ‘very poor’ category. This necessitates a ban on diesel generators, use of coal or firewood in hotels, restaurants, and open eateries, increased parking fees, and increased bus and metro frequency. The government also issues an advisory for children, the elderly, and those with respiratory problems under this stage.

- The third stage is imposed when the air quality breaches the 'severe' category. Under this stage, the government imposes a strict ban on construction and demolition activities, hot mix plants, brick kilns, and stone crushers.

- The fourth and final stage of the GRAP is enforced when the air quality is in the ‘severe plus’ category. This stage entails stopping entry of trucks except for LNG/CNG trucks and those involved in essential services, imposing a ban on diesel-operated Medium Goods Vehicles (MGVs) and Heavy Goods Vehicles (HGVs).

For Kerala, the AQI falls from Good to Moderate.

1.5. Regional Planning, Airshed & Co-ordination Mechanism:

Similar to the city air action plan prepared by non-attainment cities, it is expected that the State Government will make endeavours to promote regional action planning by Urban/Rural areas apart from non-attainment cities for improvement in their respective air quality.

A comprehensive regional plan needs to be formulated incorporating the inputs from the regional source apportionment studies & available information of emissions from various sectors. Regional Airshed approach may be adopted by the State in the preparation of State Action Plan. Timeline, Departments and Fund sources for each of the activities identified in State Action Plan need to be detailed out in the plan document. List of Activities which need to be discussed and get implemented by neighbouring States in the same Air shed also needs to be mentioned. Co-ordination committee composition for coordination and abatement of causes for air pollution, at intra and inter district / city or State level need to be shared.

1.6. Suggestions on Action plan

High Emission Zones (Hotspots) Micro plan, inputs from stakeholder consultation process, focus areas and main tasks, required policy intervention, development of action plan are to be done. The additional actions to be done are augmenting and strengthening of Air Quality Monitoring Network; Inventory of air pollution sources including hotspots or areas of concern pertaining to air pollution, Air Quality Forecasting; Air Quality Data and Information System; institutional strengthening, afforestation and green cover, public grievance redressal mechanism at state level, hot spots of air pollution are envisaged in the action plan.

2. FACTORS AFFECTING AIR QUALITY IN KERALA

The factors affecting air quality are topography, geography & meteorology, Land Use Pattern, Population & Urbanization, Economic & Industrial Development, Energy & transport and Level of Urban Services.

Air pollution is not restricted to geopolitical boundaries; pollutants can travel long distances. Air pollution depends upon meteorology, topography & land use patterns. Dispersion of air pollution occurs in both the vertical and horizontal directions. It is primarily driven by wind speed and direction, but can be influenced by topography as well. In regions with flat topography, air can move freely, dispersing pollutants and reducing the concentration of pollutants. However, in areas with complex topography, such as valleys and mountains, air movement can be restricted. Unfavorable meteorological conditions may also result in accumulation of pollutants in certain areas. Scientific data and information may be used for assessing the impact of these factors on Air Quality for development of action plan. SAP may also incorporate specific actions during unfavourable meteorological conditions.

2.1. Topography, Geography and Meteorology:

The State of Kerala is wedged between the Lakshadweep Sea and the Western Ghats. Lying between northern latitudes 8°18' and 12°48' and eastern longitudes 74°52' and 77°22', Kerala experiences humid tropical rainforest climate with some cyclones. The State has a coastline of 590 km. The width of the State varies between 11 and 121 km. Geographically, Kerala can be divided into 3 climatically distinct regions: **the eastern highlands** - rugged and cool mountainous terrain; **the central mid-lands** – rolling hills, and **the western lowlands** - coastal plains. Pre Cambrian and Pleistocene geological formations compose the bulk of Kerala's terrain. There are 44 rivers in the State. The eastern region of Kerala consists of high mountains, gorges and deep-cut valleys immediately west of the Western Ghats' rain shadow. 41 of Kerala's west-flowing rivers and 3 of its east-flowing ones originate in this region. The Western Ghats form a wall of mountains on the eastern side of Kerala except at Palakkad; hence also known Pal*ghat*, where the Palakkad Gap breaks. The Western Ghats rise to an average of 1,500 m (4,900 feet) above sea level. Anamudi in Idukki district, is the highest peak in South India, having an elevation of 2,695 m (8,842 ft). The

Western Ghats is recognized as one of the world's "hottest" biodiversity hotspots and is listed among UNESCO World Heritage Sites. The forests of this mountain chain are considered to be older than the Himalaya mountains. The Athirappilly Falls, of Western Ghat mountain ranges, is also known as *The Niagara of India*. It is part of the Chalakudy River and is the largest waterfall in the State. Wayanad is the sole Plateau in Kerala. The eastern regions in the district of Wayanad, Malappuram (Chaliyar valley at Nilamboor) and Palakkad (Attapadi Valley) together form parts of the Nilgiri Biosphere Reserve and a continuation of the Mysore Plateau and are known for natural Gold fields, along with the adjoining districts of Karnataka. Owing to its unique location in a mountain range and the Sea there is restriction of flow of air to the State from its neighbouring States.

2.2 Land Use Pattern

Kerala's forest cover is 1,081 Ha, which is 27.83% of the State's total area. The State's forest cover has increased slightly from 2019 to 2021. Wayanad District has the highest forest cover, while Alappuzha District does not have any forest area. Kerala's tree cover has decreased from 2,936 in 2019 to 2,820 in 2021.

Land Use Types	Area (in ooo'ha)	Percentage
Geographical Area	3,886	
Reporting area for land utilization	3,886	100.00
Forests	1,081	27.83
Not available for land cultivation	538	13.85
Permanent pastures and other grazing lands	0.01	0.00
Land under misc.tree crops and groves	2.65	0.07
Culturable Wasteland	101	2.59
Fallow land other than current fallows	55	1.41
Current fallows	65	1.68

Net area sown	2,043	52.57

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)

The main crops of Kerala are coconut, rubber, cashew, arecanut, tapioca, coffee, cardamom, pepper, ginger, rice, banana and other plantains. Paddy cultivation is limited to only certain regions of the State. Palakkad and Alappuzha are the two major paddy-growing regions of Kerala. In Kerala, hay is used as cattle feed and the stubble in the fields is left to be grazed by cattle or to degrade naturally until the land is tilled for the next crop. No stubble burning is practiced by the rice farmers of the State.

2.3. Population and Urbanization

There are 14 districts in Kerala., each district having its own unique peculiarities. The State's 14 districts are distributed among six regions: North Malabar (far-north Kerala), South Malabar (north-central Kerala), Kochi (central Kerala), Northern Travancore, Central Travancore (southern Kerala) and Southern Travancore (far-south Kerala). The districts which serve as administrative regions for taxation purposes are further subdivided into 27 revenue subdivisions and 77 taluks, which have fiscal and administrative powers over settlements within their borders, including maintenance of local land records. Kerala's taluks are further sub-divided into 1,674 revenue villages. Since the 73rd and 74th amendments to the Constitution of India, the Local Self Government Institutions function as a 3-tiered system, constituting of 14 District Panchayats, 152 Block Panchayats, 941 Grama Panchayats, 87 Municipalities, 6 Municipal Corporations and one Township. Mahe, a part of the Indian Union Territory of Puducherry, is a coastal exclave surrounded by Kerala on all of its landward approaches. Kannur district surrounds Mahe on three sides and Kozhikode District on the fourth.

According to the 2011 Census, the population of the State of Kerala was 3.34 crore, increasing from 3.18 crore in 2001. There were 16,027,412 males and 17,378,649 females, with a sex ratio of 92.225 males per 100 females. The percentage decadal growth during 2001-2011 was 4.91%, almost half of the 1991-2001 period. Population of Kerala had increased by 1.56 million during the decade 2001-2011.

Sl No	District	Population (2011)	Area (Km^2)	Density (people/(Km^2)
1	Alappuzha	21,27,789	1,415	1504
2	Ernakulam	32,82,388	3,063	1072
3	Idukki	11,08,974	4,356	255
4	Kannur	25,23,003	2,961	852
5	Kasargod	13,07,375	1,989	657
6	Kollam	26,35,375	2,483	1061
7	Kottayam	19,74,551	2,206	895
8	Kozhikode	30,86,293	2,345	1316
9	Malappuram	41,12,920	3,554	1157
10	Palakkad	28,09,934	4,482	627
11	Pathanamthitta	11,97,412	2,652	452
12	Thrissur	33,01,427	3,027	1508
13	Thiruvananthapuram	31,21,200	2,189	1031
14	Wayanad	8,17,420	2,130	384

2.4. Economic and Industrial Development

Traditional industries manufacturing items; coir, handlooms, and handicrafts employ around one million people. Kerala supplies 60% of the total global produce of white coir fibre. India's first coir factory was set up in Alleppey in 1859–1860. The Central Coir Research Institute was established there in 1959. As per the 2006–2007 census by SIDBI, there are 14, 68,104 micro, small and medium enterprises in Kerala employing 30, 31,272 people. KSIDC has promoted more than 650 medium and large manufacturing firms in Kerala, creating employment for 72,500 people. A

mining sector of 0.3% of GSDP involves extraction of ilmenite, kaolin, bauxite, silica, quartz, rutile, zircon and sillimanite. Other major sectors are tourism, medical sector, educational sector, banking, ship building, oil refinery, infrastructure, manufacturing, home gardens, animal husbandry and business process outsourcing.

The major industries in Kerala including Fertilizer and Chemicals Travancore Ltd.(FACT), Bharat Petroleum Corporation Ltd. (BPCL), Hindustan Organic Chemicals (HOC), and Cochin Shipyard are located in Kochi availing the advantage of the port facilities.The world famous Chavara placer deposits of the Kollam district support three major mineral industries in Kerala viz.The Indian Rare Earths Ltd. (IRE), Kerala Minerals and Metals Ltd.(KMML) at Chavara (Kollam) and The Travancore Titanium Products (TTP) at Veli (Trivandrum).

2.5. Energy and transport

2.5.1. Energy:

Total installed capacity of power in the State as on September 2023 is 3765.32 MW, of which, hydel power contributed the major share of 2173.77 MW (57.73 per cent); while 696.34 MW (159.96MW - KSEBL +536.38 MW-Private –IPP & CPP) was contributed by thermal projects (18.49 per cent), 824.94MW (21.91 per cent) from solar and 70.28 MW from wind (1.87 per cent).

2.5.2. Transport:

Kerala has a vehicle density of 62 vehicles per kilometre of road. This is a result of a significant increase in the number of vehicles in the state, from 60.7 lakh in 2011 to 148.5 lakh in 2021. In March 2016, Kerala had 305 vehicles per 1,000 people. This is higher than the national average of 18 vehicles per 1,000 people.

Kerala has a road density of 614 kilometres per 100 square kilometres, which is more than three times the national average. Two-wheelers make up two-thirds of the vehicles in Kerala. The motor transport sector is a vital part of Kerala's economy, with an annual growth rate of over 10% for the past two decades.

2.6. Level of Urban Services

The Government of Kerala has come up with the following institutional framework for solid waste management in the state with each stakeholder having a defined role:

1. The Local Self Government – Primary Agency and Stakeholder for service delivery and enforcement . Kerala State has 941 Grama Panchayats, 87 Municipalities and 6 Corporations.
2. Suchitwa Mission- Agency mandated to provide technical backstopping and financial support to the LSGIs for effective and efficient waste management service provision.
3. Clean Kerala Company - To undertake Commercial handling of nonbiodegradable waste
4. Kudumbashree for Harita Karma Sena (HKS)- A Trained team of women entrepreneurs from the Kudumbashree fold recruited to provide technical services and solutions on waste management projects, responsible for collection, transportation, storage, segregation processing, disposal, and management of waste in collaboration with the respective LSGIs.
5. MGNREGS (Mahatma Gandhi National Rural Employment Guarantee Scheme) for infrastructure development (establishment of Mini-MCFs and MCFs) through convergence; Ayyankali Urban Employment Guarantee Scheme (AUEGS) in urban areas for the same purpose
6. Haritha Keralam Mission for techno managerial support, campaigns, monitoring, and coordination.

Considering the constitutional and legal framework governing waste management in India, as well as the contextual realities of the state, the Government of Kerala has adopted a policy for solid waste management with two strategies:

1. Decentralised waste management
2. Centralised waste management where necessary.

Major role of ULBs in waste management are

- Door to Door Collection of non-biodegradable Waste coverage
- Engagement of Haritha Karma Sena for door to door collection
- User Fee Collection
- Providing Mini Material Collection Facility (MCF), Material Collection Facility (MCF), and Resource Recovery Facility (RRF) – Linkage, Contract for handing over waste

- Treatment of Biodegradable waste by decentralised or decentralized facilities
- Biomining of Legacy waste and its treatment
- Imposing penalty and prosecution against unscientific and improper disposal of waste
- Evaluation and Monitoring of Waste Management and Sanitation
- Pre- Monsoon Preparations
- Analysis of the current situation and innovations in the Waste Management Sector

3. CURRENT STATUS OF AIR QUALITY:

A comprehensive network of 39 manual ambient air quality monitoring stations has been established across Kerala, along with 9 continuous monitoring stations situated in 6 districts, to assess the ambient air quality throughout the state. These stations track key air quality parameters such as PM_{10}, SO_2, and NO_X at all manual monitoring sites, with certain stations also measuring $PM_{2.5}$. The Continuous Ambient Air Quality Monitoring Stations (CAAQMS) provide a broader scope of data, measuring additional pollutants including SO_2, NH_3, CO, O_3, PM_{10}, $PM_{2.5}$, NO_X, NO, and NO_2, among others. In addition to these pollutant measurements in continuous monitoring stations, meteorological parameters are also recorded at some of these stations to further enhance the understanding of air quality dynamics. This extensive monitoring system plays a crucial role in maintaining air quality standards and providing valuable data for environmental management and policy decisions in the state.

3.1. Air Quality Index (AQI) based zonation map of Kerala

Ambient air quality is evaluated using the Air Quality Index (AQI), a standardized system that categorizes air quality based on specific index values. AQI is a numerical scale that measures the level of air pollution in a given area. It quantifies the concentration of major air pollutants, such as: Particulate Matter (PM2.5 and PM10), Ozone (O3), Nitrogen Dioxide (NO2), Carbon Monoxide (CO), Sulfur Dioxide (SO2). Kerala State Pollution Control Board monitors 12 parameters, including PM10, PM2.5, SO2, NO2, NH3, Pb, O3, CO, Ni, As, B(a)P, and Benzene. When AQI increases air quality decreases and vice versa. AQI categorizes air quality into six levels: Good, Satisfactory, Moderate, Poor, Very Poor, and Severe, providing a simple and understandable way to communicate health risks associated with air pollution.

AQI	Remark	Color Code	Possible Health Impacts
0-50	Good		Minimal impact
51-100	Satisfactory		Minor breathing discomfort to sensitive people
101-200	Moderate		Breathing discomfort to the people with lungs, asthma and heart diseases
201-300	Poor		Breathing discomfort to most people on prolonged exposure
301-400	Very Poor		Respiratory illness on prolonged exposure
401-500	Severe		Affects healthy people and seriously impacts those with existing diseases

AQI Calculation:

AQI is calculated based on the pollutant with the highest concentration, using the AQI Calculator provided by CPCB.

Calculation of AQI

Date			Station	NSIT	
DD-MM-YYYY			City	Delhi	
			State	Delhi	

Pollutants		concentration in µg/m3 (except for CO)	Sub-Index	check	Air Quality Index
PM10	24-hr avg	121.00	114	1	
PM2.5	24-hr avg	34.00	57	1	
SO2	24-hr avg	0.00	0	0	
NO2	24-hr avg	8.00	10	1	AQI = 114
*CO (mg/m3)	max 8-hr	0.00	0	0	
O3	max 8-hr	57.00	57	1	
NH3	24-hr avg	34.00	9	1	

* Concentrations of minimum three pollutants are required; one of them should be PM10 or PM2.5
* The check displays "1" when a non-zero value is entered

As per the zonation map of 2023, based on the Air Quality data obtained from CAAQMS, NAMP and SAMP, the Annual average of Air Quality Index of Kerala ranges from Good to Moderate. The highest annual average AQI is reported at Ayyanthole (87) in Thrissur district and the lowest annual average of AQI reported at Makkamkunnu (30) in Pathanamthitta district.

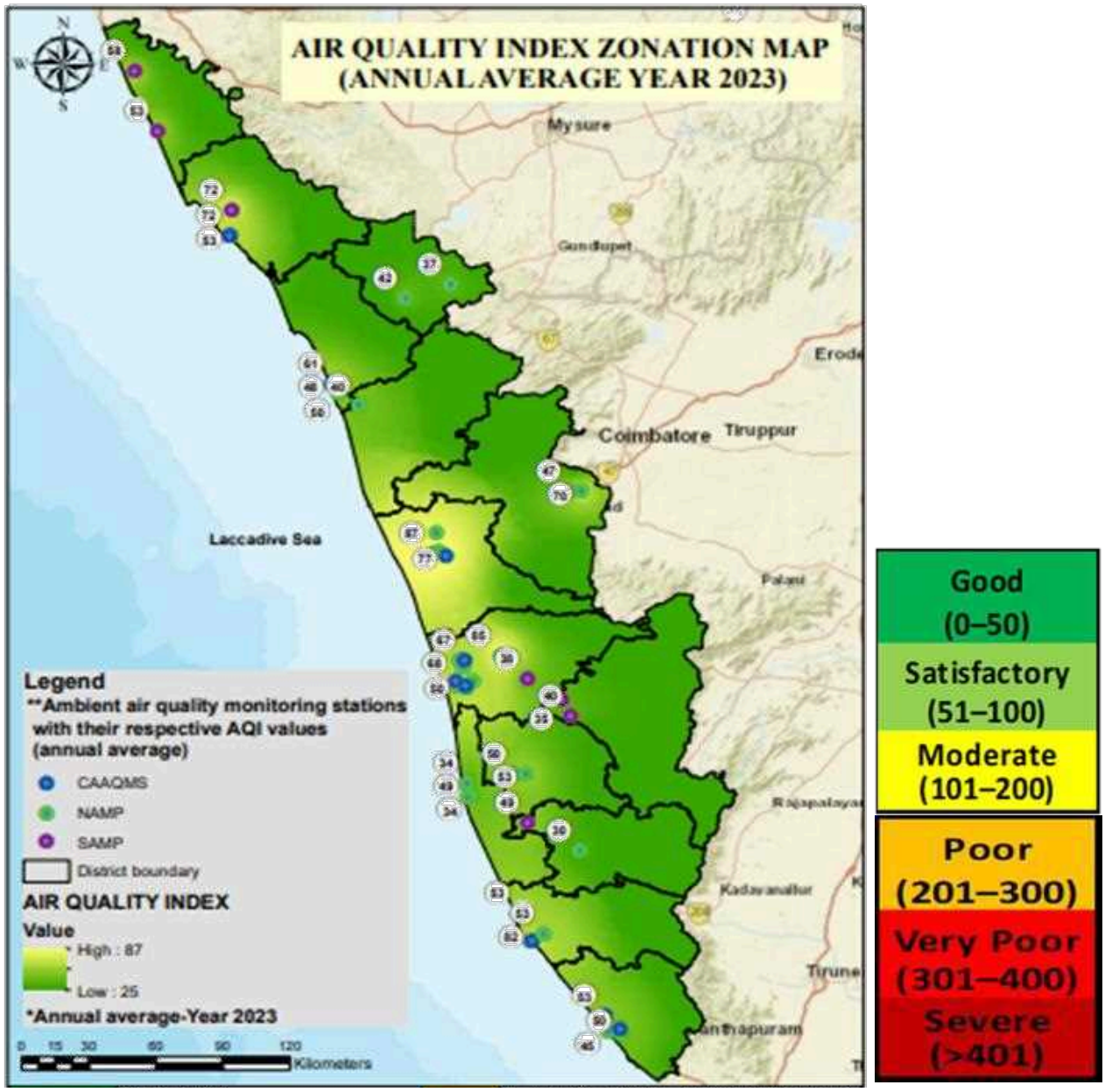


Fig. 1 Air Quality Index (AQI) based zonation map of Kerala

3.2 Continuous Ambient Air Quality Monitoring Stations (CAAQMS).

Continuous Ambient Air Quality Monitoring System (CAAQMS) is a specialized system housed in a temperature controlled container and is equipped with all necessary analyzers required for ambient air quality monitoring, calibration equipment, data acquisition (hardware and software) system with complete power backup facility. This system generates real time data and can be remotely managed.

Board has established 9 continuous air quality monitoring stations (CAAQMS) in 6 districts of Kerala (Three stations in Ernakulam, Two in Thiruvananthapuram, one each at Kollam, Thrissur, Kozhikode and Kannur). The air pollutants being monitored in these stations are Sulphur dioxide (SO2), Carbon Monoxide (CO), Particulate Matter (PM 2.5 & PM 10), Ammonia (NH3), Oxides of Nitrogen (NOx, NO, NO2). Meteorological parameters are also monitored which include Temperature, Relative humidity, Windspeed, Wind direction, Solar radiation and Rain gauge.

3.2.1 Trend in Air Quality Parameters as per the data from CAAQMS in 2023

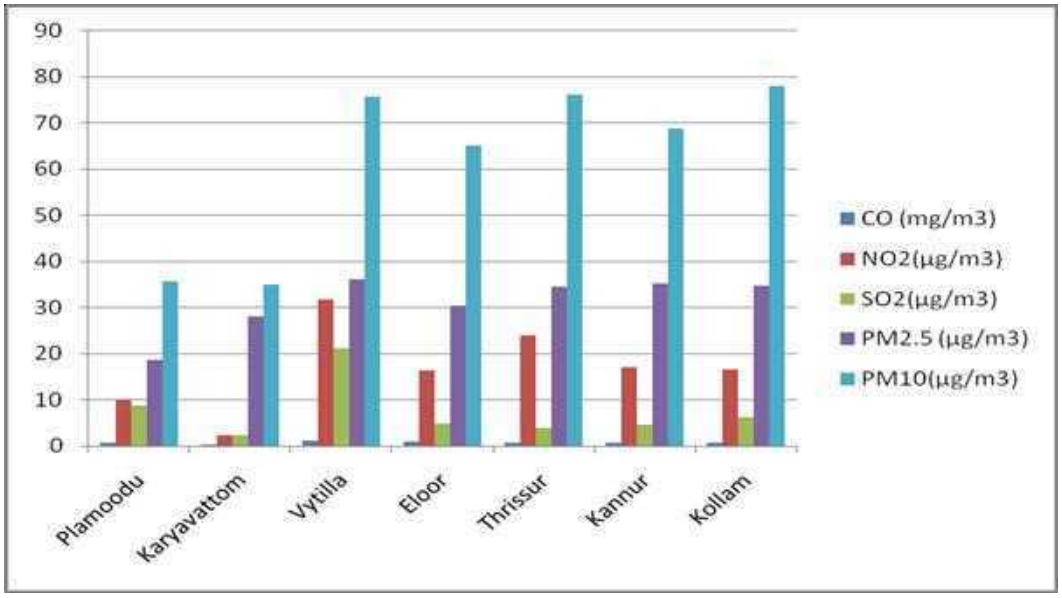


Fig 2. Annual average concentration of air pollutants in CAAQMS 2023

The graph in Fig 2. illustrates the annual average concentrations of five major air pollutants across seven locations in Kerala for 2023. Vytilla exhibits the highest levels of PM2.5

(36.09 µg/m3) and PM10 (75.78 µg/m3), indicating significant air quality challenges. Kollam and Thrissur also have elevated PM10 levels, with Kollam recording the highest at 78.04 µg/m3, raising health concerns. Conversely, Karyavattom has the lowest overall pollutant levels, reflecting comparatively cleaner air. Similar variation has been observed in the case of PM2.5. NO2 levels are notably high in Vytilla and Thrissur, further highlighting hotspots for air pollution. SO2 concentrations remain relatively lower across all locations, with the highest in Vytilla at 21.2 µg/m3. The findings underscore the need for stricter pollution control measures, particularly in urban areas like Vytilla, Kollam and Thrissur

There are two continuous ambient air quality stations namely Plamood and Kariavattom in Trivandrum and one continuous station at Polayathodu in Kollam. Based on the Continuous ambient air quality data in these stations in Kollam and of Thiruvananthapuram district, AQI for the year 2023 ranges from good to satisfactory. The improvement in air quality can be observed during the months from April to September, this may be due to high rainfall in the year. Air quality is crossing to good quality during November, December, January and February.

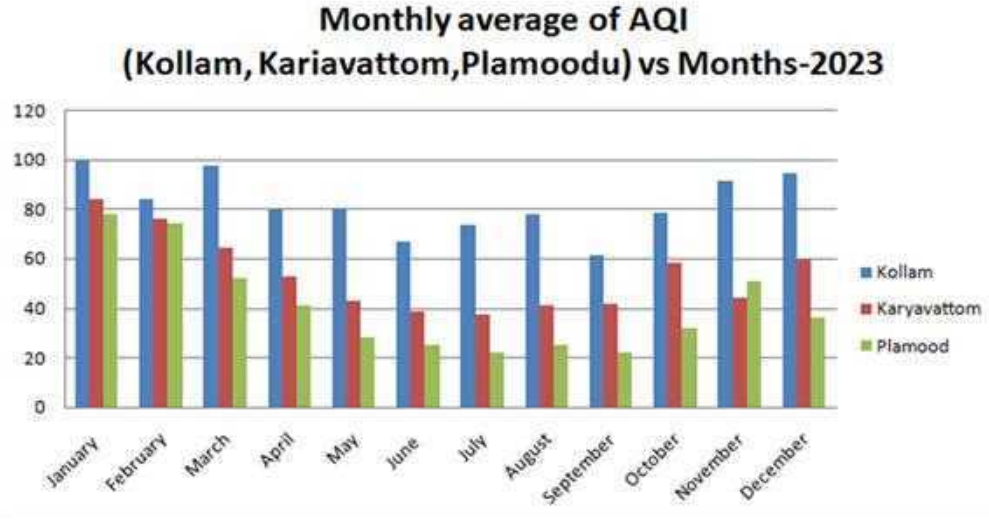


Fig.3 Monthly average AQI for Trivandrum and Kollam

There are two continuous monitoring air quality stations at Vytilla and Eloor; one station at Corporation ground in Thrissur and one station at Thavakkara in Kannur. Based on the Continuous ambient air quality data at these stations in Kannur, Ernakulam and Thrissur districts, the AQI for the year 2023 ranges from good to moderate. The air quality is exceeding the

satisfactory ranges during the month of January, February and March and exceedence is seen for Vytilla and Thrissur.

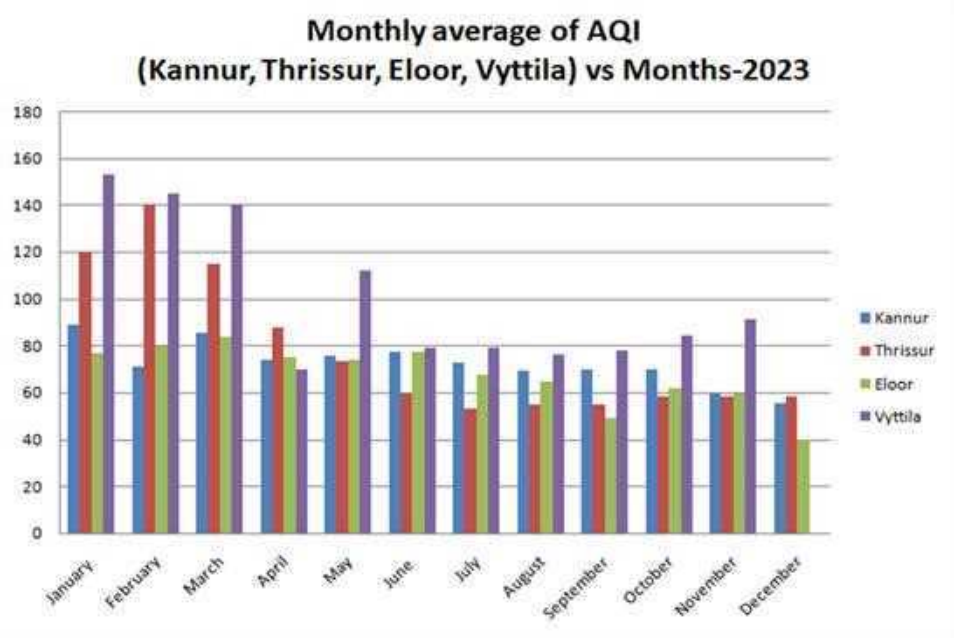


Fig.4 Monthly average AQI for Ernakulam, Thrissur and Kannur

3.2.2. Trend in Air Quality Index (AQI) as per the data from CAAQMS in 2024

Based on the Continuous ambient air quality monitored at Plamood and Karyavattom of Thiruvananthapuram district and Polayathodu of Kollam district, the AQI for the year 2024 ranges from good to moderate. The exceedence in satisfactory range has been observed for Kollam. The improvement in air quality can be obtained from May onwards.

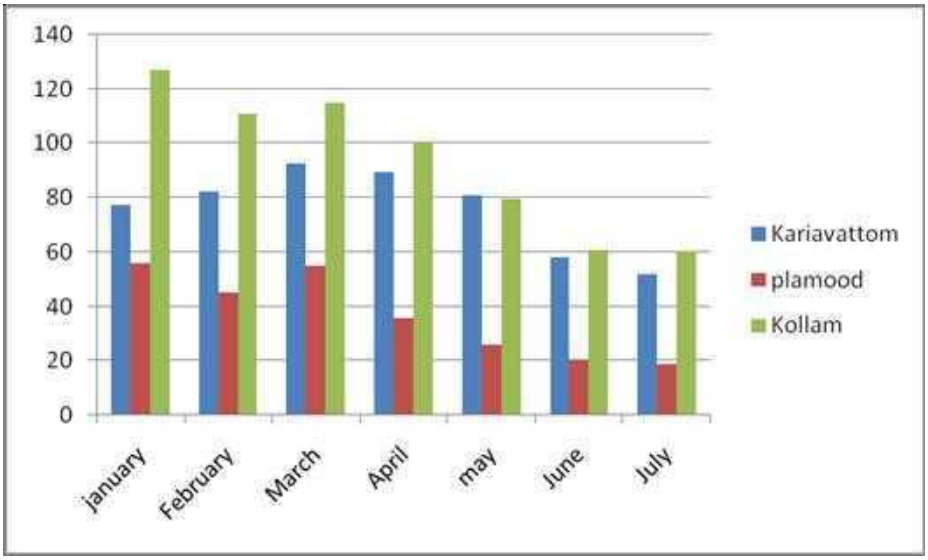


Fig. 5 Monthly average AQI (Kariavattom, Plamood, Kollam) during 2024

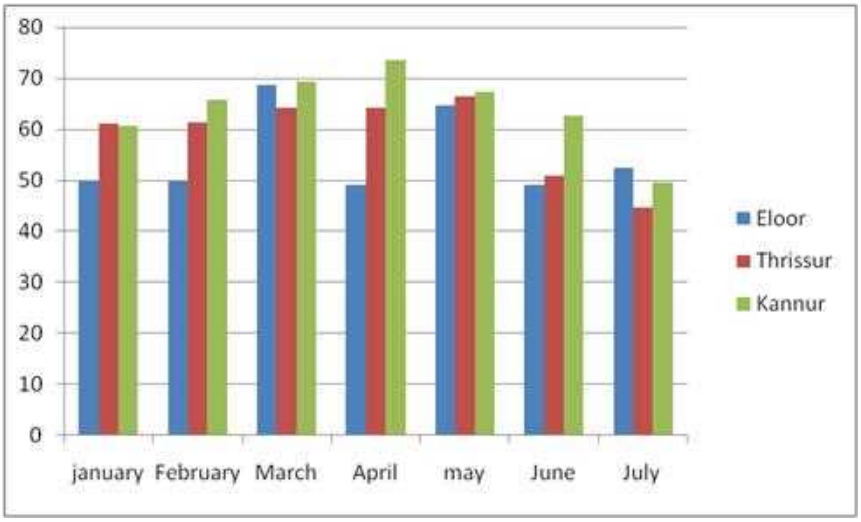


Fig. 6 Monthly average AQI (Eloor,Thrissur,Kannur) during 2024

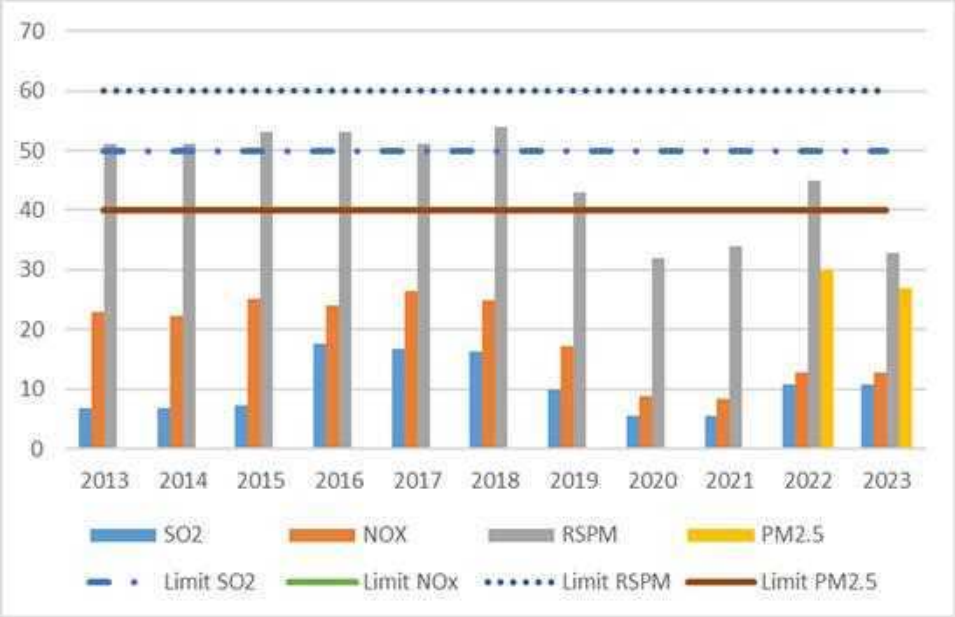
Based on the Continuous ambient air quality monitored at Eloor of Ernakulam district, Corporation ground of Thrissur district and Thavakkara of Kannur district, the AQI for the year 2024 ranges from good to satisfactory.

3.3. Air Quality based on National Ambient Air Quality Monitoring Network:

1. THIRUVANANTHAPURAM DISTRICT

1.1 FILATEX VELI **CATEGORY: INDUSTRIAL**

Trend Analysis 2013 – 2023

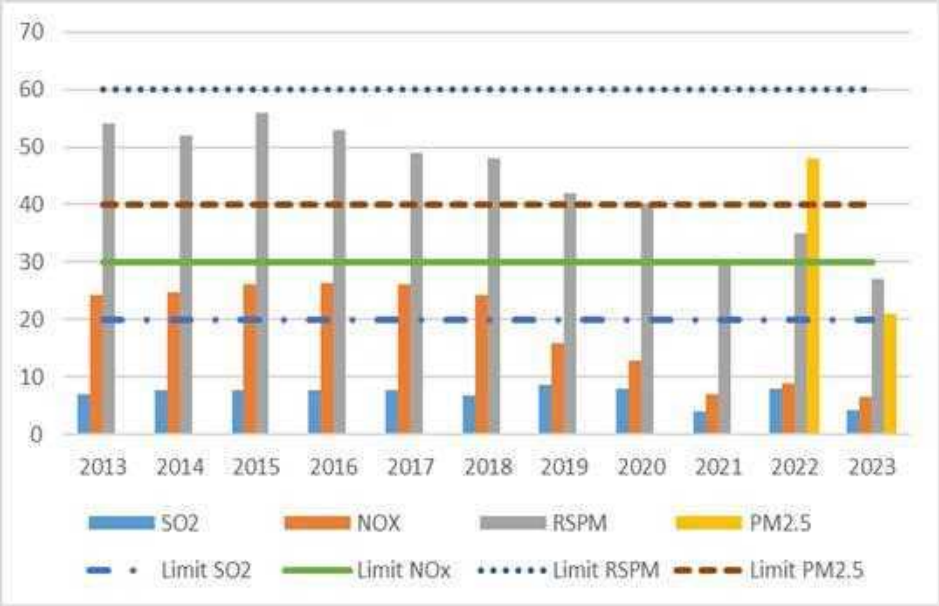


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO2	6.78	6.86	7.35	17.6	16.7	16.38	9.81	5.47	5.53	10.76	10.76	50
NOX	22.96	22.27	25.04	24.04	26.45	24.82	17.14	8.83	8.33	12.76	12.76	40
RSPM	51	51	53	53	51	54	43	32	34	45	32.83	60
PM 2.5	-	-	-	-	-	-	-	-	-	30	26.82	40

The emission levels of SO_2, NOx, RSPM, and PM2.5 from Filatex Veli, an industrial entity, have consistently remained well below their respective permissible limits from 2013 to 2023. PM2.5 data, available from 2022, is also within acceptable limits, highlighting compliance with environmental regulations.

1.2 SMV SCHOOL, OVER BRIDGE **CATEGORY: SENSITIVE**

Trend Analysis 2013 – 2023

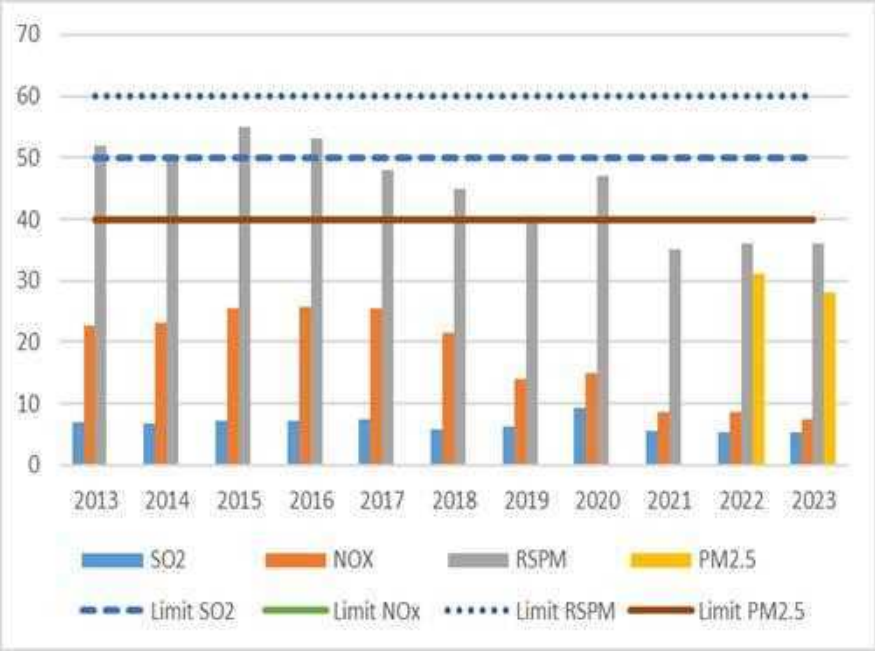


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO2	7.06	7.68	7.82	7.79	7.78	6.7	8.78	7.99	4.07	8	4.32	20
NOX	24.18	24.65	26.14	26.42	26.04	24.23	15.98	12.85	7.15	9	6.52	30
RSPM	54	52	56	53	49	48	42	40	30	35	27	60
PM 2.5	-	-	-	-	-	-	-	-	-	48	21	40

The air quality data for SMV School, categorized as a sensitive area, shows that SO_2 and NOx levels have decreased significantly over the years, particularly since 2019. RSPM levels have also declined, dropping from 54 µg/m³ in 2013 to 27 µg/m³ in 2023, indicating improved particulate matter control. PM2.5 data available from 2022, and a reduction in PM2.5 has been observed in 2023.

1.3 COSMOPOLITAN HOSPITAL, MURINJAPALAM **CATEGORY: SENSITIVE**

Trend Analysis 2013 – 2023

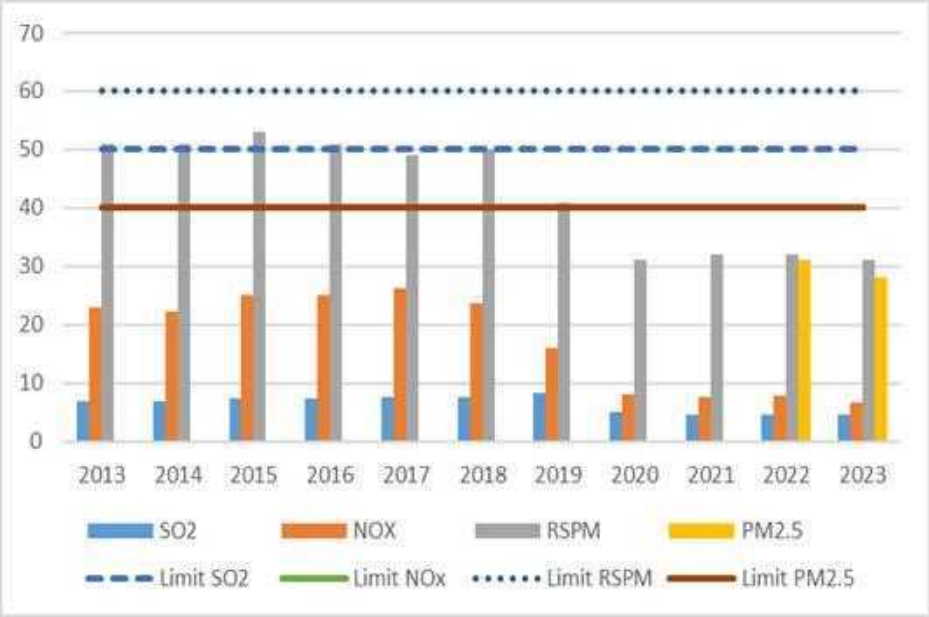


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	6.92	6.87	7.32	7.3	7.48	5.75	6.24	9.33	5.58	5.47	5.34	20
NOX	22.64	23.25	25.59	25.84	25.47	21.58	14.03	14.87	8.61	8.53	7.51	30
RSPM	52	50	55	53	48	45	40	47	35	36	36	60

The air quality data for Cosmopolitan Hospital, a sensitive area, indicates consistent compliance with pollution limits. SO_2 and NOx levels have steadily decreased over the years, with NOx showing a significant drop from 25.59 µg/m³ in 2015 to 7.51 µg/m³ in 2023. RSPM levels have also remained well within the permissible limit of 60 µg/m³.

1.4 PLAMOODU **CATEGORY: RESIDENTIAL & OTHERS**

Trend Analysis 2013 – 2023



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	6.78	6.86	7.35	7.36	7.7	7.49	8.23	5.00	4.50	4.65	4.61	50
NOX	22.96	22.27	25.04	24.99	26.13	23.69	16.01	7.96	7.64	7.79	6.77	40
RSPM	51	51	53	51	49	50	41	31	32	32	31	60
PM2.5	*	*	*	*	*	*	*	*	*	31	28	40

The air quality data for Plamoodu, categorized as a residential area, shows that pollutant levels have consistently remained within permissible limits. SO_2 levels have remained low, with a gradual reduction from 6.78 µg/m³ in 2013 to 4.61 µg/m³ in 2023, well below the limit of 50 µg/m³. NOx emissions have significantly declined from 25.04 µg/m³ in 2015 to 6.77µg/m³ in 2023. RSPM and PM2.5 levels have also stayed under their respective limits, indicating improved air quality in this residential area over the years.

2. KOLLAM DISTRICT

2.1 KSPCB, DO, KADAPAKKADA CATEGORY: RESIDENTIAL & OTHERS

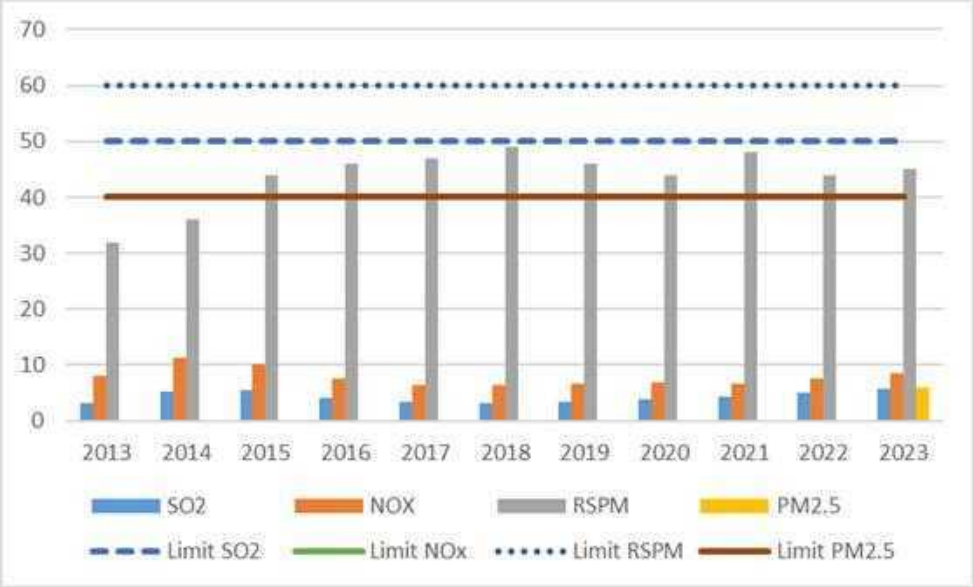
Trend Analysis 2013 – 2023

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	5.34	3.76	4.46	4.04	2.34	2.02	2.19	2.25	2.25	4.09	5.54	50
NOX	14.63	9.49	10.03	7.46	4.5	4.54	4.43	4.84	5.07	5.78	8.94	40
RSPM	40	34	47	45	39	45	45	46	47	44	45	60
PM2.5	-	-	-	-	-	-	-	-	-	-	22	40

The air quality data for KSPCB, DO, Kadapakkada, a residential area, demonstrates that pollutant levels have remained well within permissible limits over the years. SO_2 levels have consistently stayed low, showing minor fluctuations but maintaining a safe range under the 50 µg/m³, with a recent value of 5.54 µg/m³ in 2023. NOx levels have significantly decreased from 14.63 µg/m³ in 2013 to 8.94 µg/m³ in 2023, reflecting effective emission control. RSPM and PM2.5 levels have also remained below their limits, ensuring good air quality in this residential region.

2.2 KMML, CHAVARA **CATEGORY: INDUSTRIAL**

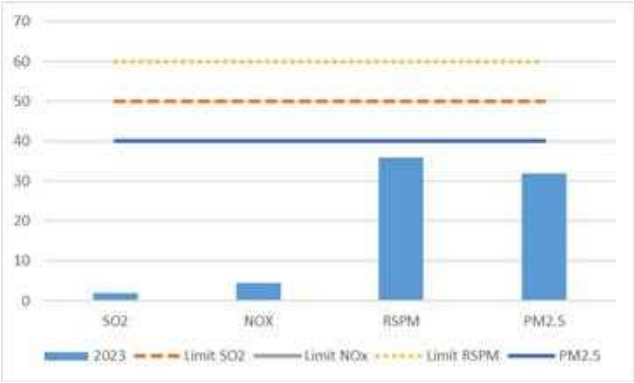
Trend Analysis 2013 – 2023



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	3.22	5.33	5.52	4.07	3.39	3.09	3.33	3.85	4.33	5.04	5.77	50
NOX	8.05	11.38	10.12	7.59	6.45	6.39	6.59	6.98	6.74	7.67	8.53	40
RSPM	32	36	44	46	47	49	46	44	48	44	45	60
PM2.5	-	-	-	-	-	-	-	-	-	-	6	40

The air quality data for KMML, Chavara, an industrial area, indicates that pollutant levels have consistently stayed well within the permissible limits. SO_2 levels have remained extremely low, fluctuating slightly but reaching only 5.77 µg/m³ in 2023, far below the limit of 50 µg/m³. NOx emissions have similarly stayed low, with a gradual decrease from 11.38 µg/m³ in 2014 to 8.53 µg/m³ in 2023, remaining under the 40 µg/m³. RSPM and PM2.5 levels have also been maintained within acceptable ranges.

2.3 KMML, KARIKODE **CATEGORY: RESIDENTIAL**



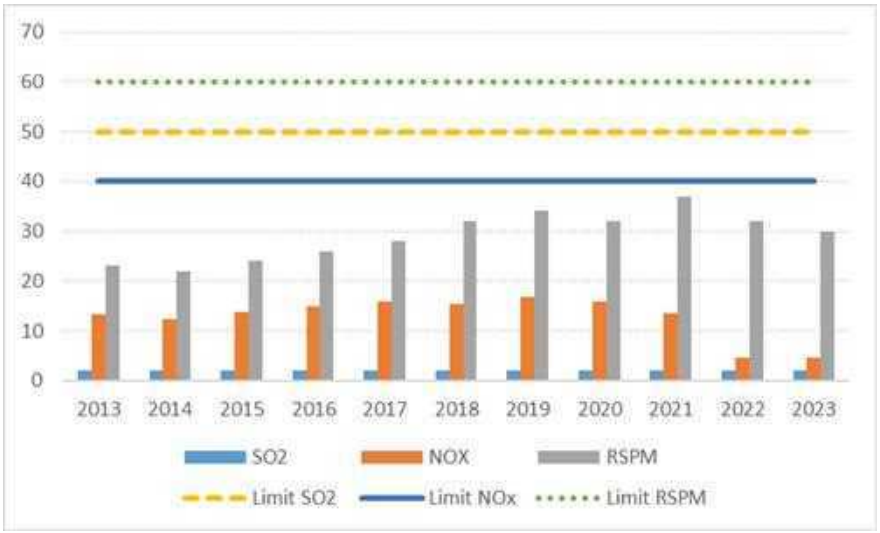
	2023	LIMIT
SO_2	5.68	50
NOX	9.00	40
RSPM	42	60
PM2.5	32	40

The air quality data for KMML, Karikode, a residential area, for 2023 shows that all measured pollutant levels are well within permissible limits. SO_2 and NOx levels are at 5.68µg/m³ and 9.00 µg/m³, respectively, far below their respective limits of 50 µg/m³ and 40µg/m³. Similarly, RSPM and PM2.5 levels are recorded at 42 µg/m³ and 32 µg/m³, indicating good air quality in the area.

3. PATHANAMTHITTA DISTRICT

3.1 MAKKAMKUNNU **CATEGORY: RESIDENTIAL & OTHERS**

Trend Analysis 2013 – 2023

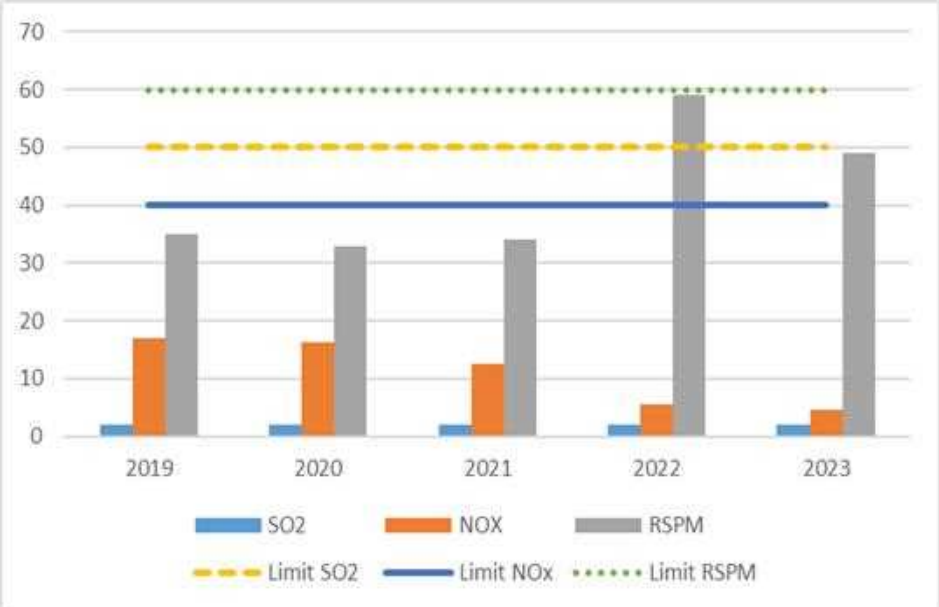


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	50
NOX	13.38	12.36	13.68	14.88	15.94	15.39	16.87	15.92	13.57	4.54	4.52	40
RSPM	23	22	24	26	28	32	34	32	37	32	30	60

The air quality data for Makkamkunnu, categorized as a residential area, shows that pollutant levels have consistently remained well within permissible limits. SO_2 levels have remained constant at a very low value of 2.0 µg/m³ throughout the years, far below the limit of 50 µg/m³. NOx levels showed a significant decline in recent years, dropping from 16.87 µg/m³ in 2019 to 4.52 µg/m³ in 2023, well under the 40 µg/m³. RSPM levels have also been consistently low, with a slight reduction from 37 µg/m³ in 2021 to 30 µg/m³in 2023, reflecting good air quality in the region.

3.2 THIRUVALLA **CATEGORY: RESIDENTIAL & OTHERS**

Trend Analysis 2019 – 2023



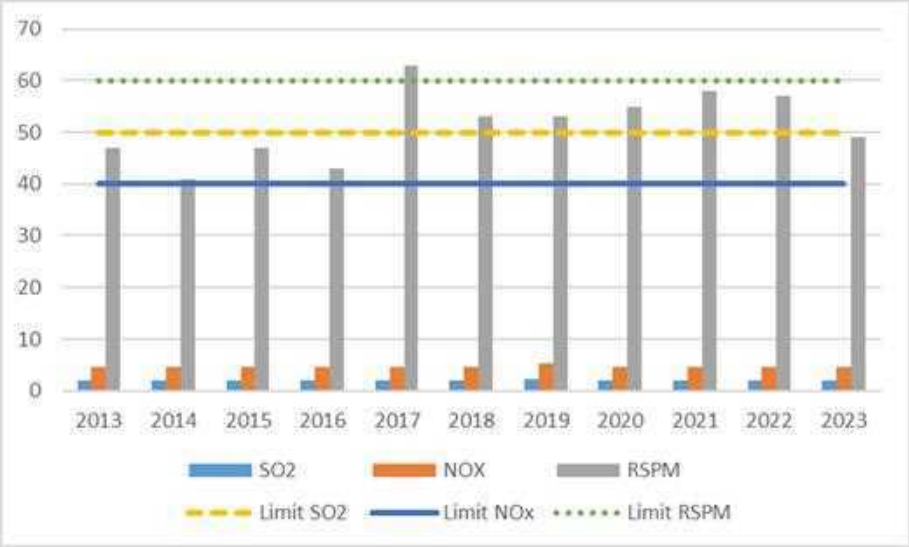
	2019	2020	2021	2022	2023	LIMIT
SO2	2	2	2	2	2.00	50
NOX	16.91	16.32	12.48	5.48	4.50	40
RSPM	35	33	34	59	49	60

The air quality data for Thiruvalla, categorized as a residential area, shows that all pollutant levels are well within permissible limits. SO_2 levels have consistently remained at a low value of 2.0 µg/m³, far below the limit of 50 µg/m³. NOx and RSPM levels have shown improvement, with NOx decreasing significantly from 16.91 µg/m³ in 2019 to 4.50 µg/m³ in 2023, and RSPM staying under the 60 µg/m³ despite minor fluctuations.

4. ALAPPUZHA DISTRICT

4.1 WILLIAM GOODACRE CATEGORY: INDUSTRIAL

Trend Analysis 2013 – 2023

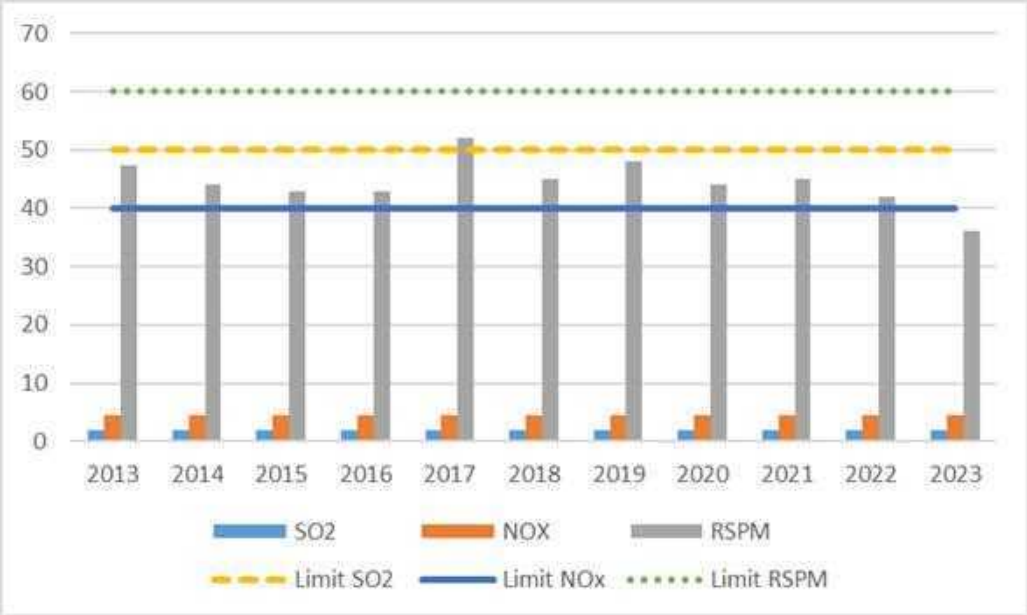


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO2	2	2	2	2	2	2	2.18	2.06	2.01	2.01	2.02	50
NOX	4.5	4.5	4.5	4.5	4.5	4.5	5.19	4.53	4.51	4.51	4.52	40
RSPM	47	41	47	43	63	53	53	55	58	57	49	60

The air quality data for William Goodacre, an industrial area, shows that SO_2 levels have remained consistently low, with values ranging from 2 to 2.18 µg/m³, well below the permissible limit of 50 µg/m³. NOx emissions have remained stable around 4.5 µg/m³, with a slight increase to 5.19 µg/m³ in 2019 and a small reduction thereafter, staying well under the 40 µg/m³. RSPM levels have fluctuated but remained under the limit of 60 µg/m³, peaking at 63 µg/m³ in 2017 and reducing to 49 µg/m³ in 2023. Overall, the area shows good compliance with environmental standards, with steady control over emissions.

4.2 THONDAMKULANGARA **CATEGORY: INDUSTRIAL**

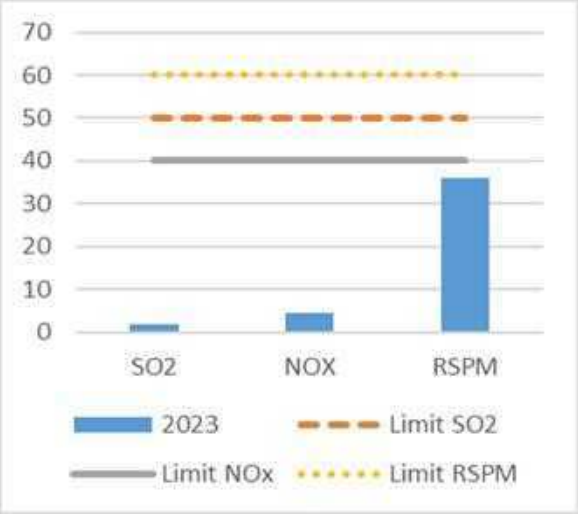
Trend Analysis 2013 – 2023



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2	2	2	2	2	2	2	2	2	2	2	50
NOX	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	40
RSPM	47.24	44.16	43	43	52	45	48	44	45	42	36	60

The air quality data for Thondamkulangara, an industrial area, shows consistent compliance with environmental standards. SO_2 levels have remained constant at 2 µg/m³, well within the permissible limit of 50 µg/m³. NOx emissions have remained stable at 4.5 µg/m³ throughout the years, also well below the 40 µg/m³. RSPM levels, though fluctuating, have consistently stayed under the 60 µg/m³, with a notable improvement to 36 µg/m³ in 2023.

4.3 PALM FIBRE **CATEGORY: INDUSTRIAL**



	2023	LIMIT
SO_2	2.00	50
NOX	4.51	40
RSPM	34	60

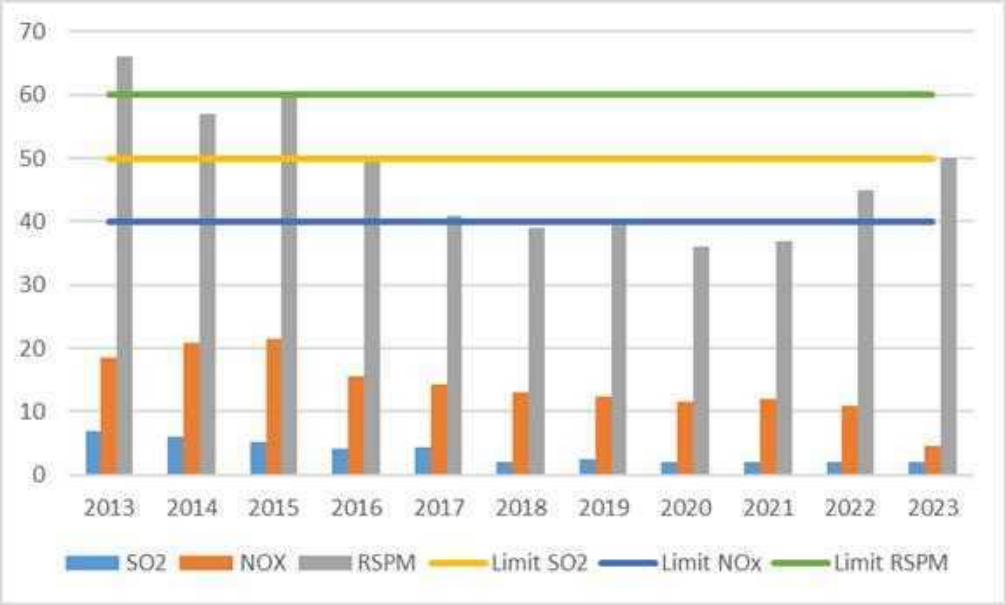
The air quality data for Palm Fibre industrial area indicates consistent compliance with environmental standards SO_2 and NOx emissions have been maintained significantly below their respective permissible limits. RSPM levels remain well within the allowable limit of 60µg/m³ units, recording 34 µg/m³ in 2023.

5. KOTTAYAM DISTRICT

5.1 NAGAMPADOM

CATEGORY: RESIDENTIAL & OTHERS

Trend Analysis 2013 – 2023

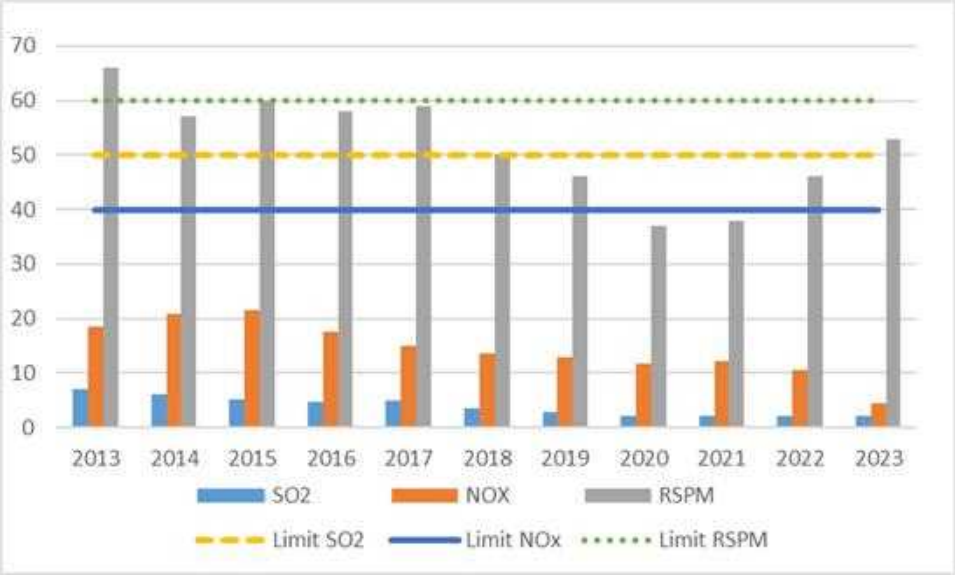


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO2	6.93	6.11	5.24	4.13	4.42	2	2.4	2.01	2.00	2.00	2.07	50
NOX	18.44	20.92	21.4	15.6	14.19	12.94	12.44	11.59	12.04	10.85	4.50	40
RSPM	66	57	60	50	41	39	40	36	37	45	50	60

The air quality data for Nagampadom, a residential area, shows a significant improvement in SO_2 levels, which decreased from 6.93 µg/m³ in 2013 to 2.00 in 2022, well below the 50 µg/m³. NOx emissions, however, remained relatively high until 2022, with a noticeable reduction to 4.50 µg/m³ in 2023, in line with the permissible limit of 40 µg/m³. RSPM levels have fluctuated but have stayed within the 60 µg/m³, with a slight increase to 50 µg/m³ in 2023. Overall, the area demonstrates steady progress in reducing air pollutants, improving air quality for its residents.

5.2 VADAVATHOOR **CATEGORY: INDUSTRIAL**

Trend Analysis 2013 – 2023



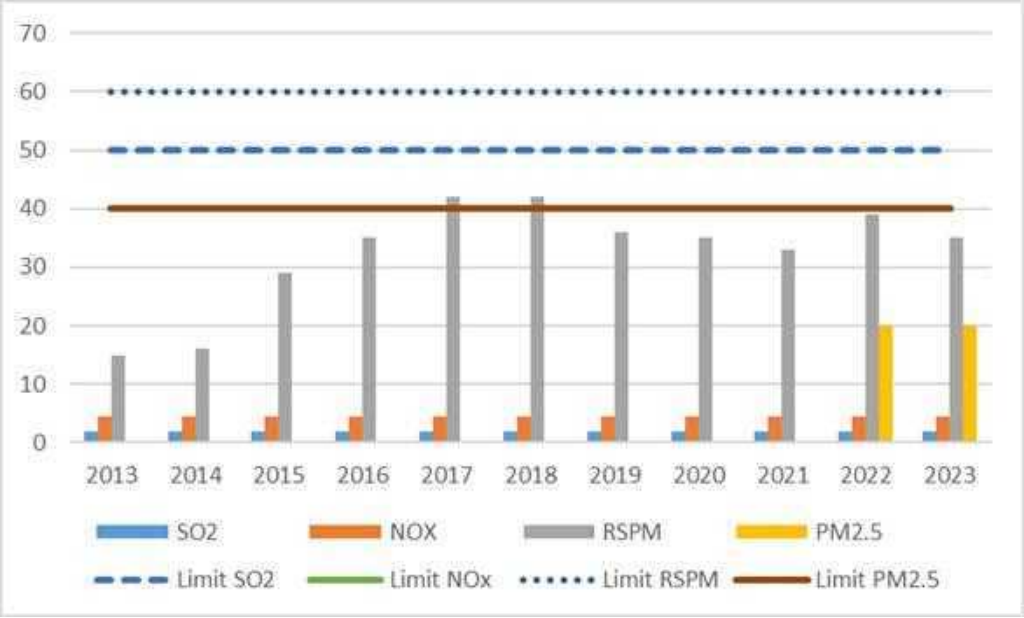
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO2	6.93	6.11	5.24	4.6	4.85	3.46	2.72	2.04	2.01	2.01	2.08	50
NOX	18.44	20.92	21.42	17.51	14.94	13.51	12.87	11.67	12.07	10.52	4.50	40
RSPM	66	57	60	58	59	50	46	37	38	46	53	60

The air quality data for Vadavathoor, an industrial area, shows consistent improvement in pollutant levels over the years. SO_2 emissions have steadily decreased from 6.93 µg/m³ in 2013 to 2.08 µg/m³ in 2023, remaining far below the permissible limit of 50 µg/m³. NOx levels have also declined from 18.44 µg/m³ in 2013 to 4.50 µg/m³ in 2023, in line with the limit of 40 µg/m³. RSPM levels have fluctuated but have remained within the 60 µg/m³, reaching 53µg/m³ in 2023.

6. IDUKKI DISTRICT

6.1 THODUPUZHA CATEGORY: RESIDENTIAL, RURAL & OTHERS

Trend Analysis 2013 – 2023

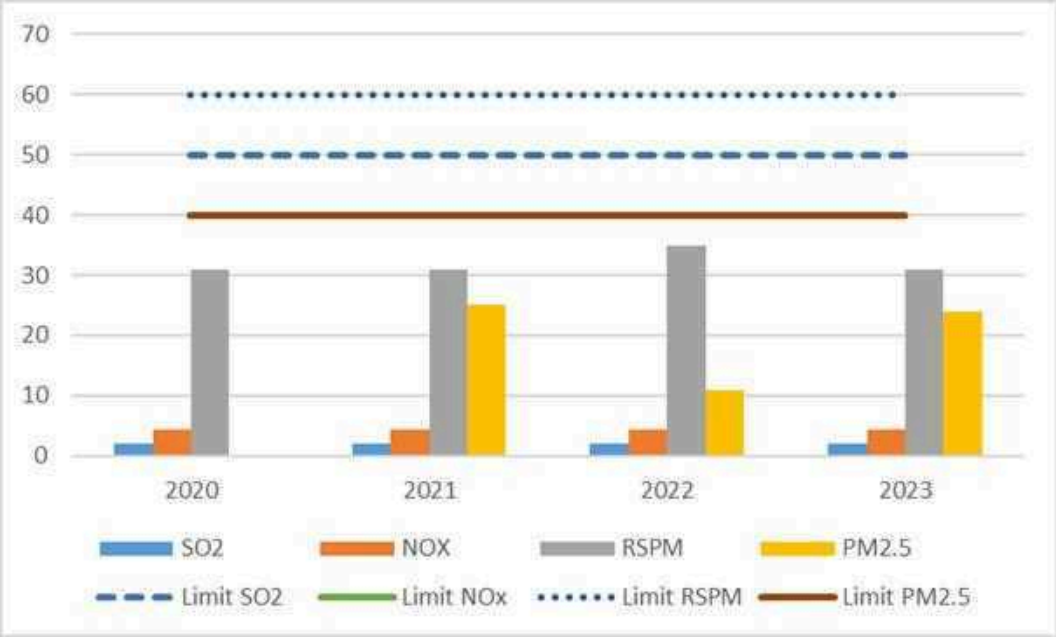


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO2	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	50
NOX	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	40
RSPM	15	16	29	35	42	42	36	35	33	39	35	60
PM2.5	*	*	*	*	*	*	*	*	*	20	20	40

The air quality data for Thodupuzha, a residential and rural area, shows that SO_2 and NOx levels have remained consistently low and well within permissible limits over the years. SO_2 levels have stayed constant at 2.00 µg/m³, well below the 50- µg/m³, and NOx levels have remained at 4.50 µg/m³, well below the 40- µg/m³. RSPM levels have fluctuated but remained below the 60 µg/m³, with a slight decrease to 35 in 2023. PM2.5 levels, recorded from 2022 onwards, are within the 40 µg/m³.

6.2. MUTTOM **CATEGORY: RESIDENTIAL, RURAL & OTHERS**

Trend Analysis 2020 – 2023



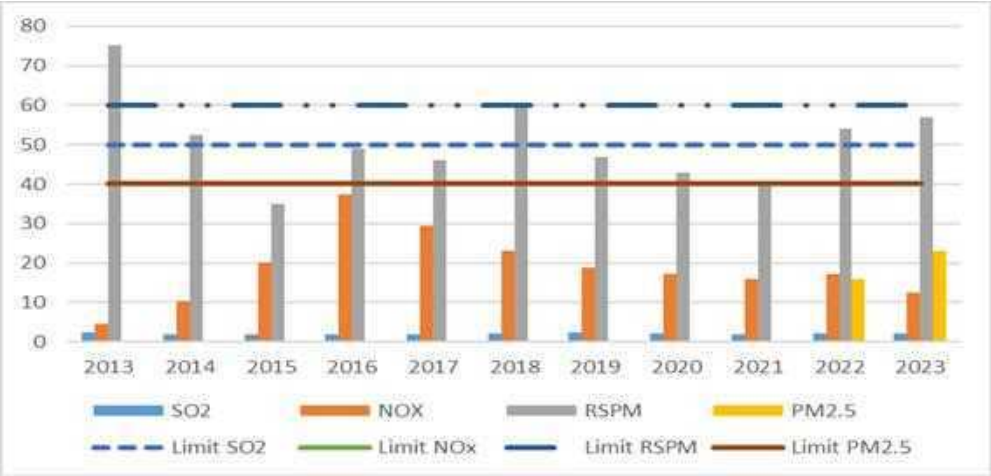
	2020	2021	2022	2023	LIMIT
SO_2	2.00	2.00	2.00	2.00	50
NOX	4.50	4.50	4.50	4.50	40
RSPM	31	31	35	31	60
PM 2.5	-	25.2	11	24	40

The air quality data for Muttom, a residential and rural area, indicates that pollutant levels were not recorded from 2012 to 2018. However, starting in 2019, SO_2 and NOx levels were recorded at 2.00 µg/m³ and 4.50 µg/m³, respectively, both well within the permissible limits. RSPM levels have remained consistently below the 60- µg/m³, with a slight fluctuation, reaching 35 in 2022. PM2.5 levels, which were recorded from 2021, showed improvement, with a value of 11 in 2022 and 24 in 2023, still within the 40 µg/m³ limit.

7. ERNAKULAM DISTRICT

7.1 ELOOR METHANAM CATEGORY: RESIDENTIAL

Trend Analysis 2013 – 2023

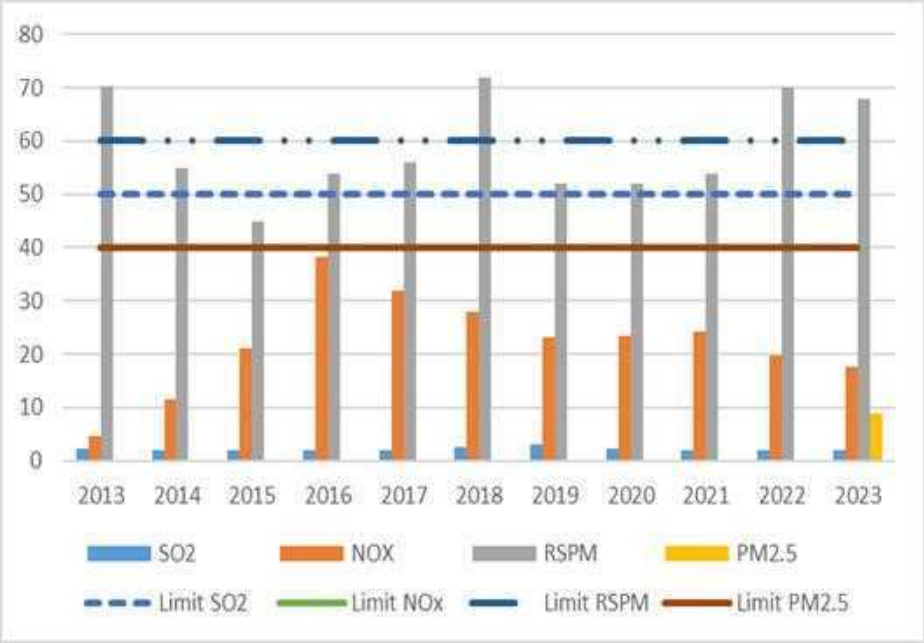


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.40	2.00	2.00	2	2	2.21	2.53	2.05	2.00	2.03	2.02	50
NOX	4.58	10.46	20.1	37.45	29.43	23.17	18.7	17.31	15.82	17.13	12.56	40
RSPM	75.20	52.43	35	49	46	60	47	43	40	54	57	60
PM2.5	*	*	*	*	*	*	*	*	*	16	23	40

The air quality data for Eloor Methanam, a residential area, shows that SO_2 levels have remained consistently low, with values fluctuating between 2.00 µg/m³ and 2.53 µg/m³., well within 50 µg/m³. NOx levels saw a significant rise between 2013 and 2016, peaking at 37.45 µg/m³., but have decreased in recent years, reaching 12.56 µg/m³ in 2023, still under the 40µg/m³. RSPM levels have fluctuated, with a peak of 75.20 µg/m³ in 2013, but remained within the 60 µg/m³ in 2023 at 57 µg/m³. PM2.5 levels, recorded from 2022, were 16 µg/m³ in 2022 and slightly increased to 23µg/m³ in 2023, still within the permissible limit of 40 µg/m³.

7.2 ELOOR TCC **CATEGORY: INDUSTRIAL**

Trend Analysis 2013 – 2023



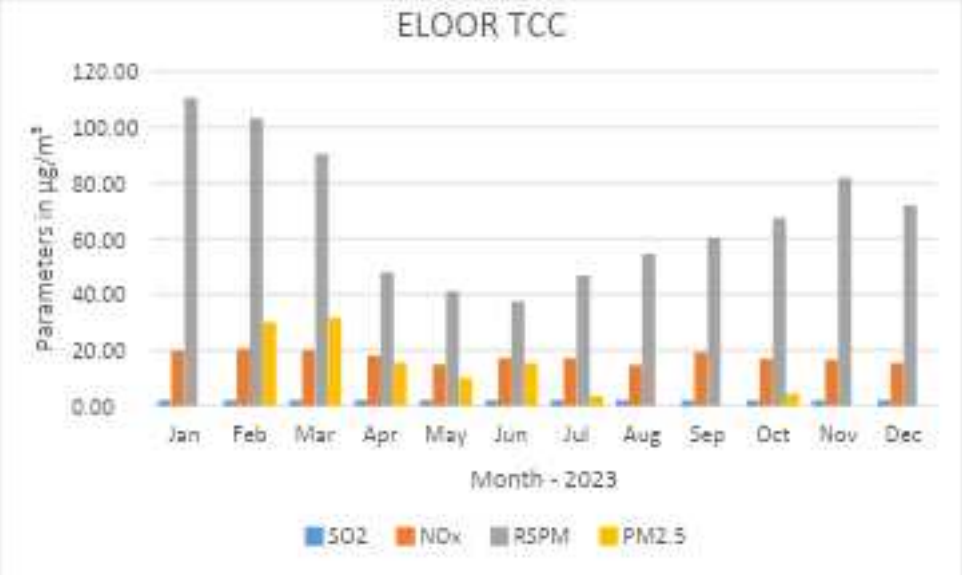
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.34	2.00	2.00	2	2	2.63	2.98	2.21	2.01	2.12	2.00	50
NOX	4.57	11.66	21.19	38.24	31.97	28.08	23.29	23.49	24.37	19.85	17.51	40
RSPM	70.34	55.01	45	54	56	72	52	52	54	70	68	60
PM2.5	*	*	*	*	*	*	*	*	*	*	9	40

The air quality data for the Eloor TCC industrial area shows that SO_2 emissions have consistently remained well below the permissible limit of 50 µg/m³. While NOx levels fluctuate significantly over the years, they have shown a declining trend, remaining within the allowable limit by 2023. RSPM levels have occasionally approached the limit of 60 µg/m³, highlighting the need for continuous monitoring, but PM2.5 levels are well-controlled. Overall, the data reflects

improvements in air quality, though sustained efforts are essential to ensure compliance and mitigate potential concerns.

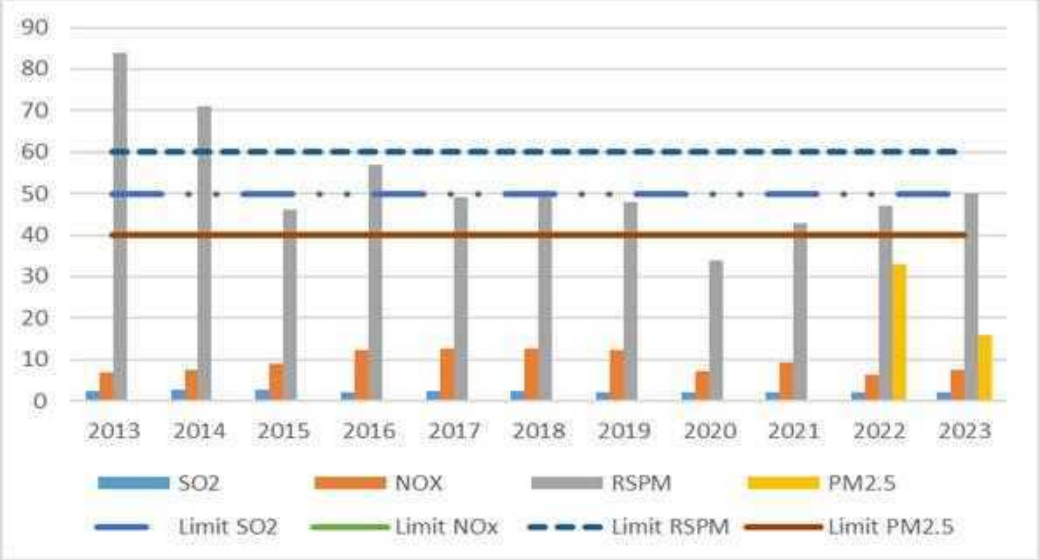
Ambient Air Quality Data - 2023

Parameter	SO_2	NOx	RSPM	PM2.5
Jan	2.00	19.80	110.53	-
Feb	2.00	20.40	103.26	30
Mar	2.00	20.00	90.44	31.7
Apr	2.00	18.02	47.95	15.57
May	2.00	14.79	41.17	9.97
Jun	2.00	17.16	37.50	15.40
Jul	2.00	17.15	46.81	3.62
Aug	2.00	14.63	54.56	-
Sep	2.00	19.35	60.43	-
Oct	2.00	16.91	67.43	4.25
Nov	2.00	16.52	81.88	-
Dec	2.00	15.44	71.99	-



7.3 ERNAKULAM SOUTH OVERBRIDGE **CATEGORY: RESIDENTIAL, RURAL & OTHERS**

Trend Analysis 2013 – 2023



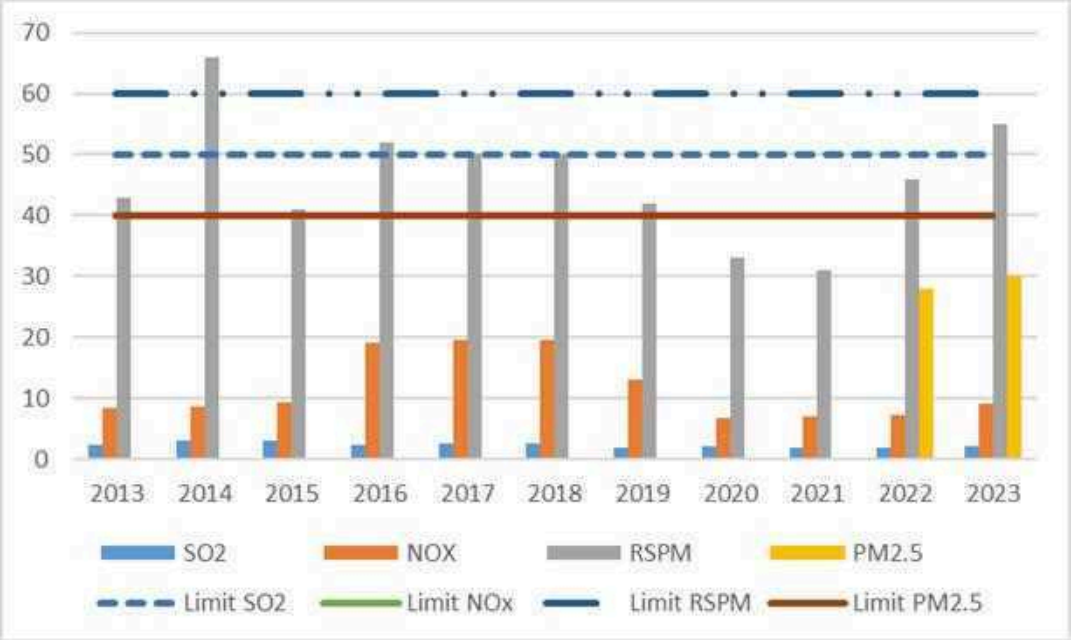
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.46	2.6	2.75	2.23	2.42	2.42	2.00	2.08	2.00	2.00	2.08	50
NOX	7.04	7.44	9.06	12.27	12.52	12.53	12.46	7.25	9.27	6.39	7.41	40
RSPM	84	71	46	57	49	49	48	34	43	47	50	60
PM2.5	*	*	*	*	*	*	*	*	*	33	16	40

The air quality data for South Overbridge, a residential and rural area, indicates that SO_2 levels have remained consistently low, fluctuating between 2.00 µg/m³ and 2.75 µg/m³, well within the 50 µg/m³. NOx levels showed an upward trend from 2013 to 2016, peaking at 12.53 µg/m³, but reduced to 7.41 µg/m³ in 2023, remaining below the 40 µg/m³. RSPM levels have

fluctuated, with a peak of 84 µg/m³ in 2013, but they stayed within the 60 µg/m³, reaching 50 in 2023, while PM2.5 levels were recorded at 16 in 2023, also under the permissible 40 µg/m³ limit.

7.4 VYTTILA **CATEGORY: RESIDENTIAL, RURAL & OTHERS**

Trend Analysis 2013 – 2023

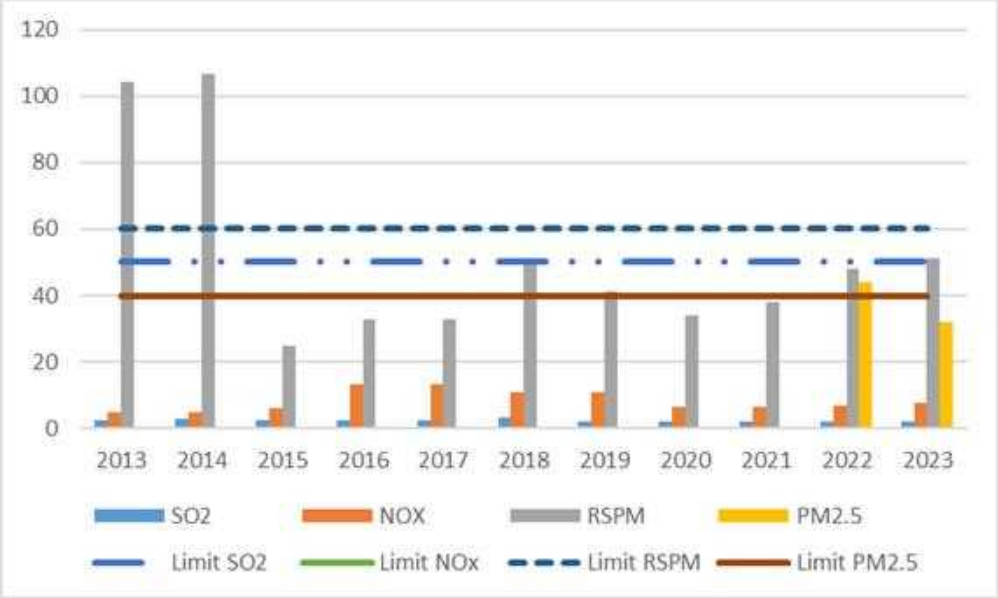


		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
	SO_2	2.47	3.00	3.09	2.3	2.71	2.71	2.00	2.13	2.00	2.00	2.13	50
	NOX	8.54	8.74	9.43	19.23	19.55	19.53	13.16	6.81	7.01	7.30	9.08	40
	RSPM	43	66	41	52	50	50	42	33	31	46	55	60
	PM2.5	*	*	*	*	*	*	*	*	*	28	30	40

The air quality data for Vyttila, a residential and rural area, shows that SO_2 levels fluctuated between 2.00 µg/m³ and 3.09 µg/m³, remaining well within the permissible 50µg/m³. NOx levels was 9.08 µg/m³ in 2023, staying below the 40 µg/m³. RSPM levels were fluctuating over the years, peaking at 66 µg/m³ in 2014, but they stayed within the 60- µg/m³, reaching 55 µg/m³ in 2023, while PM2.5 levels were recorded at 30 in 2023, below the 40 µg/m³ limit.

7.5 IRUMPANAM **CATEGORY: INDUSTRIAL**

Trend Analysis 2013 – 2023



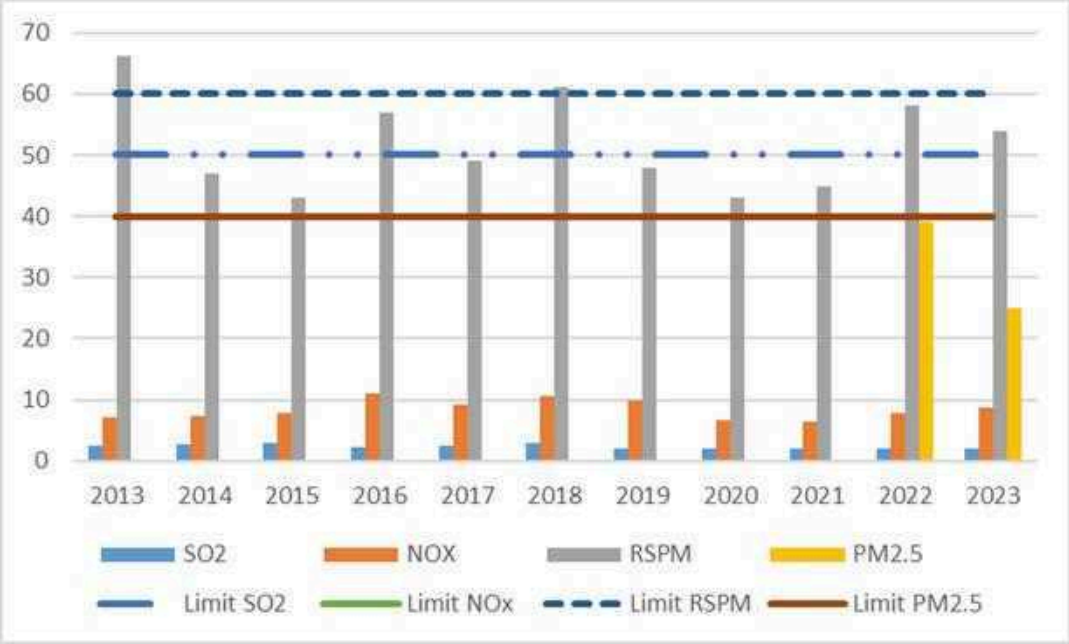
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.39	2.73	2.66	2.28	2.28	3.19	2.02	2.21	2.00	2.00	2.21	50
NOX	4.96	5.03	5.98	13.14	13.14	10.67	11.05	6.63	6.46	6.82	7.54	40
RSPM	104.30	106.64	25	33	33	51	41	34	38	48	51	60
PM2.5	*	*	*	*	*	*	*	*	*	44	32	40

The air quality data for Irumpanam, an industrial area, indicates that SO_2 levels have remained consistently low and well within the permissible limit of 50 µg/m³. NOx levels, while showing fluctuations, have consistently stayed below the allowable limit of 40 µg/m³. RSPM levels have improved significantly since 2014, remaining within the 60 µg/m³, though some

increase was observed in recent years. Regarding PM2.5 levels, which exceeded in 2022 but remained within the permissible limit of 40 µg/m³.

7.6 KALAMASSERY **CATEGORY: INDUSTRIAL**

Trend Analysis 2013 – 2023



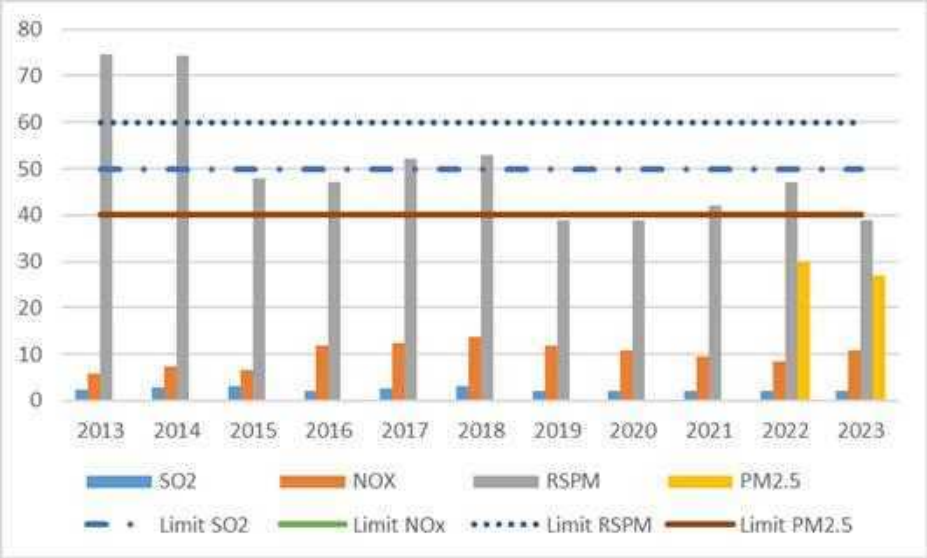
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.46	2.63	2.94	2.18	2.43	3.07	2.02	2.05	2.00	2.00	2.05	50
NOX	7.14	7.30	7.92	11.01	9.21	10.55	9.97	6.58	6.55	7.77	8.69	40
RSPM	66.32	47.02	43	57	49	61	48	43	45	58	54	60
PM2.5	*	*	*	*	*	*	*	*	*	39	25	40

The air quality data for Kalamassery, an industrial area, reveals that SO_2 levels have consistently remained well within the permissible limit of 50 µg/m³. NOx levels, while fluctuating, have stayed significantly below the limit of 40 µg/m³ throughout the years. RSPM

levels have been within the 60 µg/m³, showing occasional increases but staying compliant overall. Regarding PM2.5 levels, it remained below the 40 µg/m³ limit in 2023.

7.7 MG ROAD **CATEGORY: RESIDENTIAL & OTHERS**

Trend Analysis 2013 – 2023



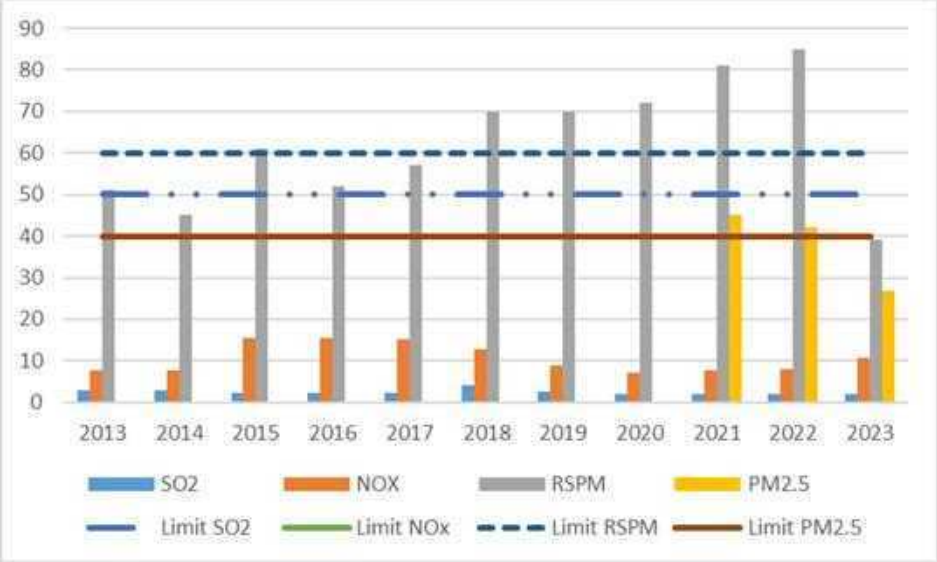
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.36	2.86	3.09	2.21	2.55	3.12	2	2.10	2.00	2.0	2.1	50
NOx	5.83	7.51	6.51	11.77	12.31	13.62	11.86	10.78	9.40	8.5	10.7	40
RSPM	74.50	74.39	48	47	52	53	39	39	42	47	39	60
PM2.5	*	*	*	*	*	*	*	*	*	30	27	40

The air quality data for MG Road, a residential area, indicates that SO_2 levels have consistently remained well within the permissible limit of 50 µg/m³ over the years. NOx levels, while fluctuating, have decreased in recent years, staying below the limit of 40 µg/m³ in 2023. RSPM levels have shown significant improvement, consistently remaining within the allowable

limit of 60 µg/m³, while PM2.5 levels recorded in 2022 and 2023 are well-controlled and below the 40 µg/m³ limit.

7.8 PERUMBAVOOR (KUTTIPPADAM) **CATEGORY: RESIDENTIAL & OTHERS**

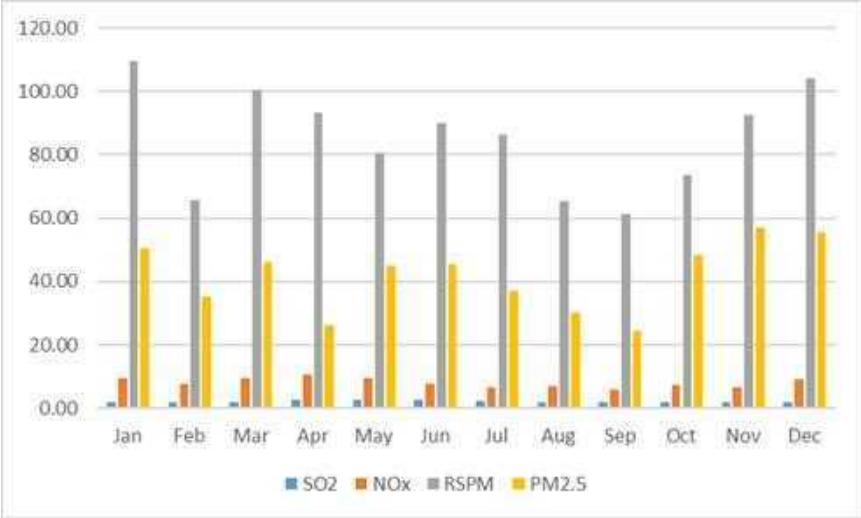
Trend Analysis 2013 – 2023



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.89	3.00	2.16	2.22	2.42	4.15	2.75	2.03	2.04	2.13	50
NOX	7.78	7.72	15.35	15.48	15.2	12.9	8.94	7.14	7.59	8.03	40
RSPM	51.11	45	61	52	57	70	70	72	81	85	60
PM2.5	-	-	-	-	-	-	-	-	45	42	40

The air quality data for Perumbavoor (Kuttippadam), a residential area, indicates that SO_2 levels have consistently remained well below the permissible limit of 50 µg/m³. NOx levels, while fluctuating, have stayed within the allowable limit of 40 µg/m³ in recent years. However, RSPM levels have exceeded the limit of 60 µg/m³, indicating significant air quality challenges.

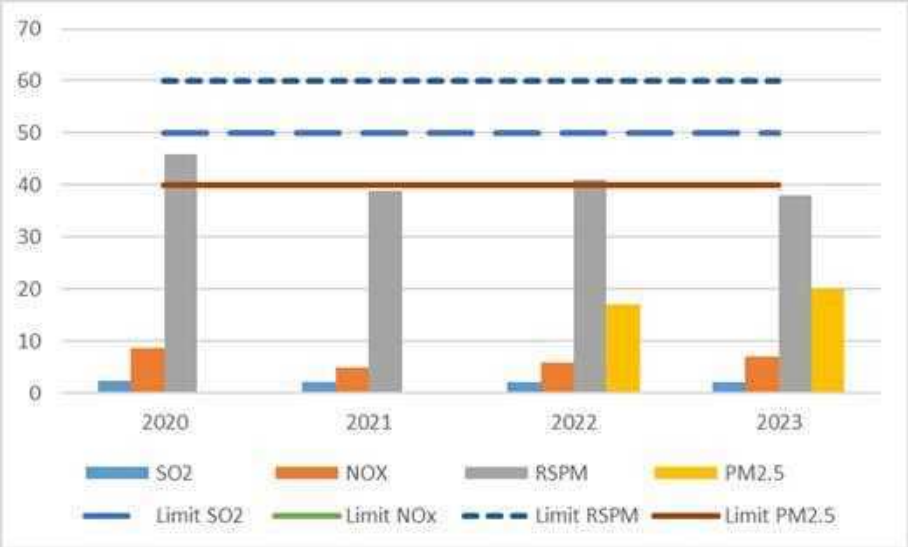
Parameter	SO_2	NOx	RSPM	PM2.5
Jan	2.04	9.32	109.60	51
Feb	2.04	7.82	65.52	35
Mar	2.00	9.53	100.56	46
Apr	2.47	10.57	93.30	26
May	2.42	9.31	80.67	45
Jun	2.46	7.49	89.81	45
Jul	2.13	6.74	86.25	37
Aug	2.00	7.04	65.33	30
Sep	2.00	5.81	61.26	24
Oct	2.00	7.15	73.67	48
Nov	2.00	6.57	92.41	57
Dec	2.00	9.01	104.11	55



Particulate Matter rises. More industrial units like plywood units are situated in the region and the emissions from the source are to be controlled.

7.9 MUVATTUPUZHA **CATEGORY: COMMERCIAL**

Trend Analysis 2020 – 2023



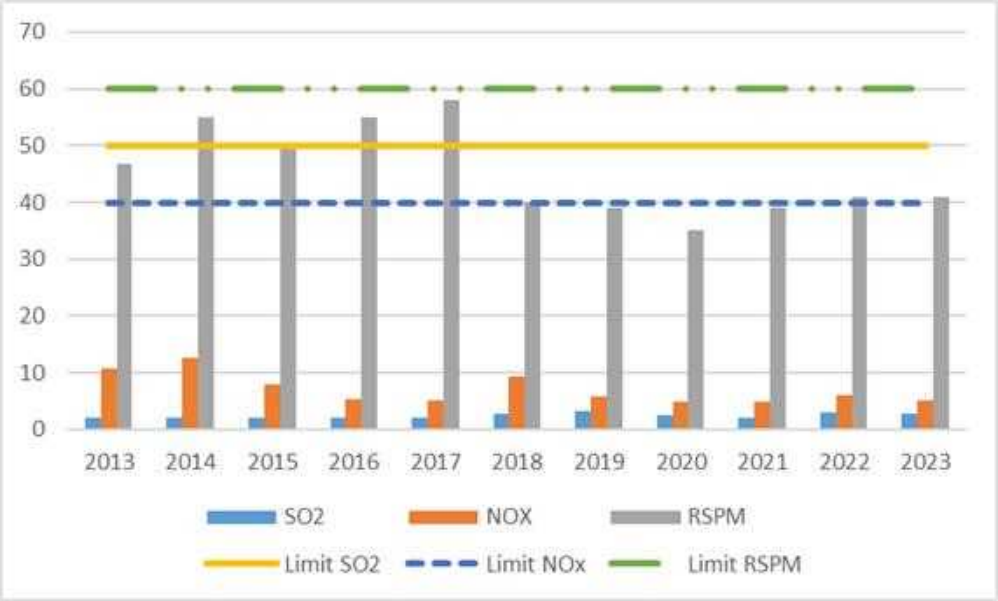
	2020	2021	2022	2023	LIMIT
SO_2	2.46	2.03	2.02	2.23	50
NOX	8.62	5.02	5.97	6.91	40
RSPM	46	39	41	38	60
PM2.5	*	*	17	20	40

The air quality data for Muvattupuzha, a commercial area, demonstrates that SO_2 levels have remained consistently low and well within the permissible limit of 50 µg/m³. NOx levels, while showing some variation, are well below the limit of 40 µg/m³. RSPM levels have consistently remained within the permissible limit of 60 µg/m³, with a slight downward trend in recent years. PM2.5 levels, recorded since 2022, are also well-controlled and remain below the 40 µg/m³ limit, indicating good air quality in the area.

8 THRISSUR DISTRICT

8.1 POONKUNNAM CATEGORY: RESIDENTIAL & OTHERS

Trend Analysis 2013 – 2023

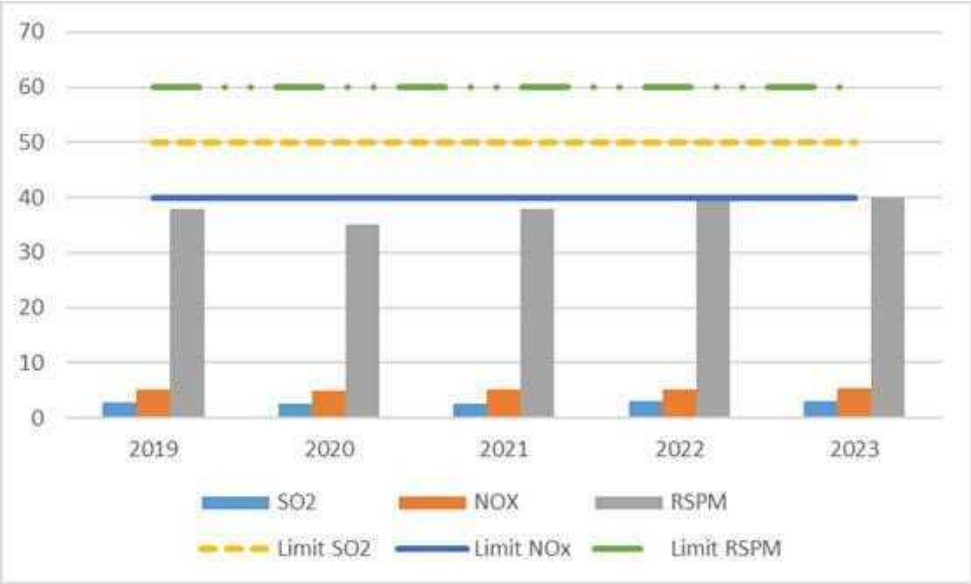


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.00	2.00	2.00	2.01	2.01	2.77	3.24	2.44	2.17	3.04	2.84	50
NOX	10.80	12.64	8.01	5.45	5.12	9.26	5.92	4.92	4.96	6.01	5.23	40
RSPM	46.74	55.01	50	55	58	40	39	35	39	41	41	60

The air quality data for Poonkunnam, a residential area, shows that SO_2 levels have consistently remained well within the permissible limit of 50 µg/m³. NOx levels have shown a declining trend over the years, staying significantly below the allowable limit of 40 µg/m³. RSPM levels have consistently complied with the limit of 60 µg/m³, reflecting effective particulate matter management.

8.2 PERINGANDOOR **CATEGORY: INDUSTRIAL**

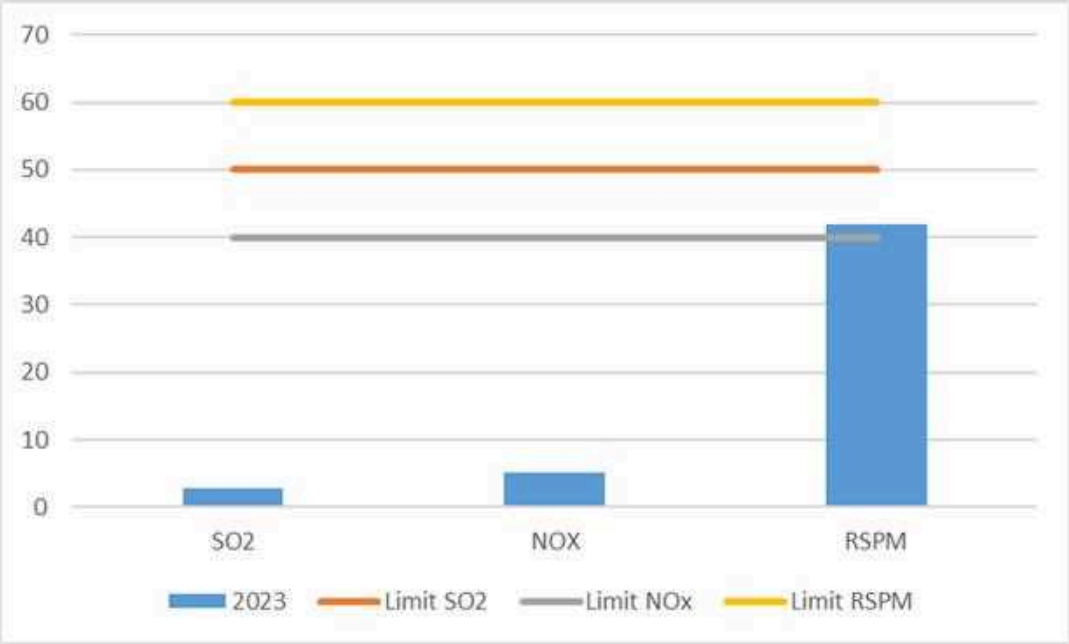
Trend Analysis 2019 – 2023



	2019	2020	2021	2022	2023	LIMIT
SO2	2.69	2.47	2.48	2.93	2.93	50
NOX	5.12	4.80	5.06	5.18	5.29	40
RSPM	38	35	38	40	40	60

The air quality data for Peringandoor, an industrial area, shows that SO_2 levels have consistently remained low and well within the permissible limit of 50 µg/m³. NOx levels have also stayed far below the limit of 40 µg/m³, with only minor fluctuations over the years. RSPM levels have been well-controlled, consistently remaining below the 60 µg/m³.

8.3 AYYANTHOLE **CATEGORY: RESIDENTIAL**



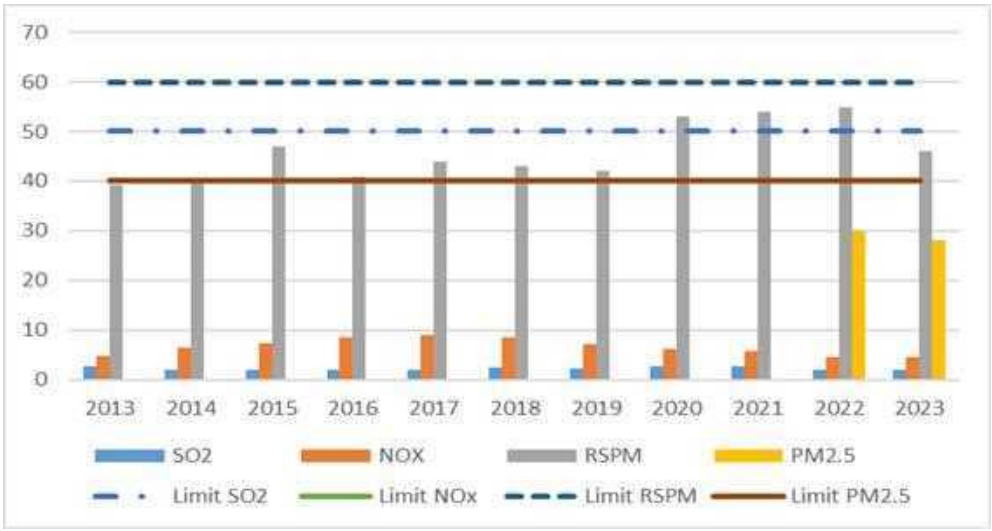
	2023	LIMIT
SO2	2.74	50
NOX	5.04	40
RSPM	42	60

The air quality data for Ayyanthole, a residential area, shows that SO_2 and NOx levels are well within their permissible limits of 50 µg/m³and 40 µg/m³, respectively. RSPM levels are also within the allowable limit of 60 µg/m³s.

9 PALAKKAD DISTRICT

9.1 KANJIKODE CATEGORY: INDUSTRIAL

Trend Analysis 2013 – 2023

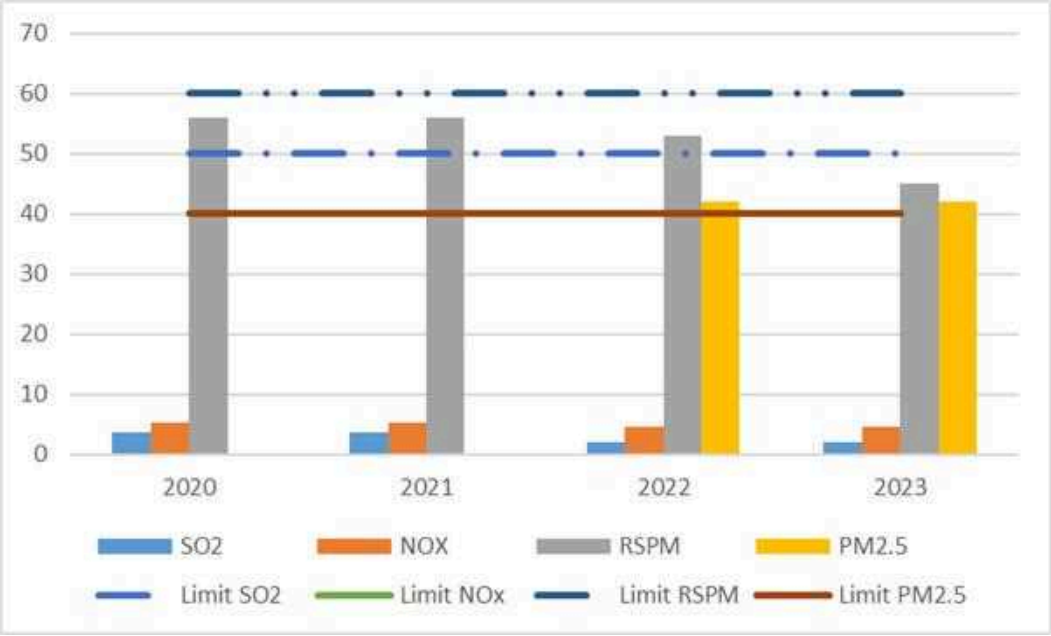


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.70	2.00	2.00	2	2	2.54	2.19	2.75	2.67	2.03	2.04	50
NOX	4.74	6.41	7.42	8.56	8.96	8.61	7.14	6.24	5.76	4.56	4.52	40
RSPM	39.26	40.19	47	41	44	43	42	53	54	55	46	60
PM2.5	*	*	*	*	*	*	*	*	*	30	28	40

The air quality data for Kanjikode, an industrial area, shows that SO_2 levels have remained consistently low and well within the permissible limit of 50 µg/m³. NOx levels have fluctuated but have stayed below the 40 µg/m³. RSPM levels have been within the 60 µg/m³ although a slight increase over the years is observed, requiring ongoing monitoring. PM2.5 levels recorded in 2022 and 2023 are well within the allowable limit of 40 µg/m³. Industrial units like steel mills are situated in the region. Here emissions is to be controlled.

9.2 BEML LTD **CATEGORY: INDUSTRIAL**

Trend Analysis 2020 – 2023

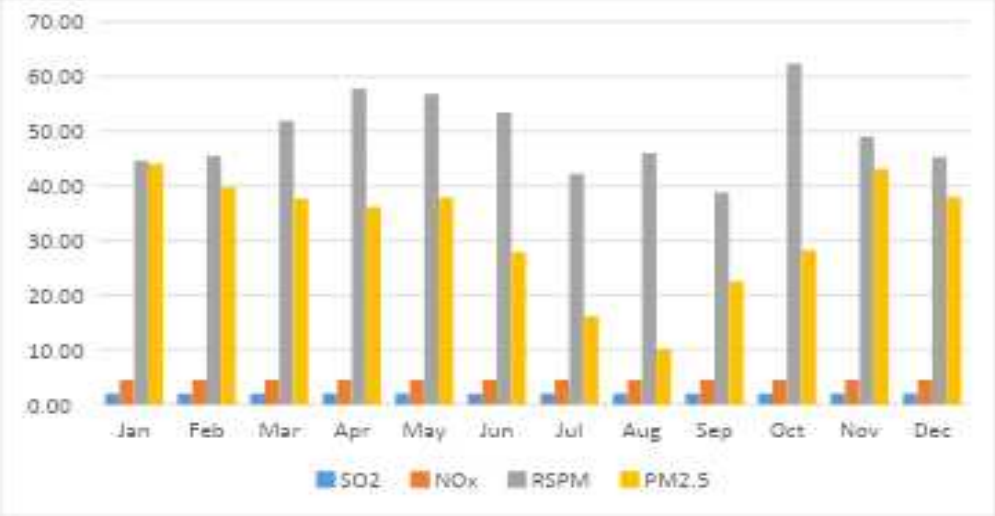


	2020	2021	2022	2023	LIMIT
SO_2	3.65	3.65	2	2.00	50
NOX	5.36	5.36	4.5	4.50	40
RSPM	56	56	53	45	60
PM2.5	*	*	42	42	40

The air quality data for BEML Ltd, an industrial area, shows that SO_2 levels have remained well within the permissible limit of 50 µg/m³ over the years. NOx levels have also been consistently below the 40 µg/m³. RSPM levels have stayed within the allowable limit of 60 µg/m³, though a slight decrease was observed in 2023. PM2.5 levels recorded in 2022 and 2023 are slightly above the permissible limit of 40 µg/m³, indicating the need for further measures to

reduce fine particulate pollution.The level of PM2.5 is more from the month of November to May.

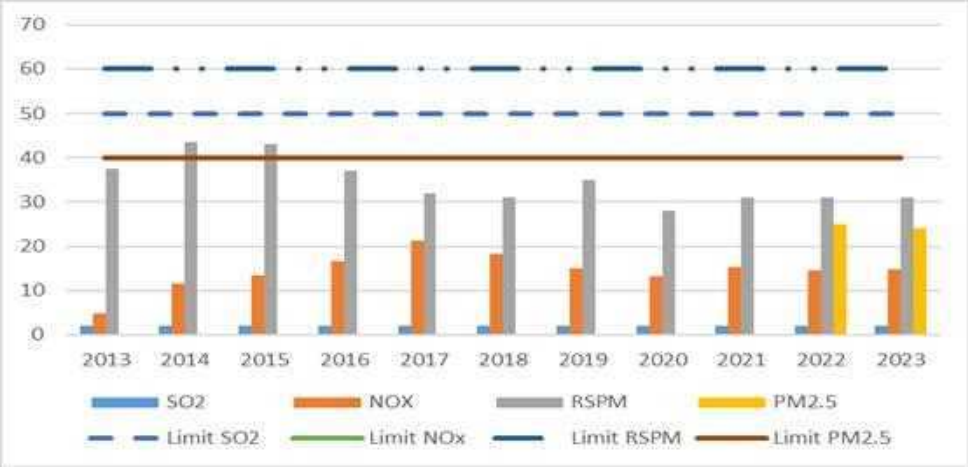
Parameter	SO2	NOx	RSPM	PM2.5
Jan	2.00	4.50	44.54	44.00
Feb	2.00	4.50	45.46	39.72
Mar	2.00	4.50	51.89	37.64
Apr	2.00	4.50	57.71	36.14
May	2.00	4.50	56.80	37.90
Jun	2.00	4.50	53.40	27.89
Jul	2.00	4.50	42.22	16.14
Aug	2.00	4.50	46.00	10.11
Sep	2.00	4.50	38.78	22.56
Oct	2.00	4.50	62.40	28.20
Nov	2.00	4.50	49.00	43.11
Dec	2.00	4.50	45.27	38.00



10 MALAPPURAM DISTRICT

10.1 KAKKANCHERRY CATEGORY: INDUSTRIAL

Trend Analysis 2013 – 2023



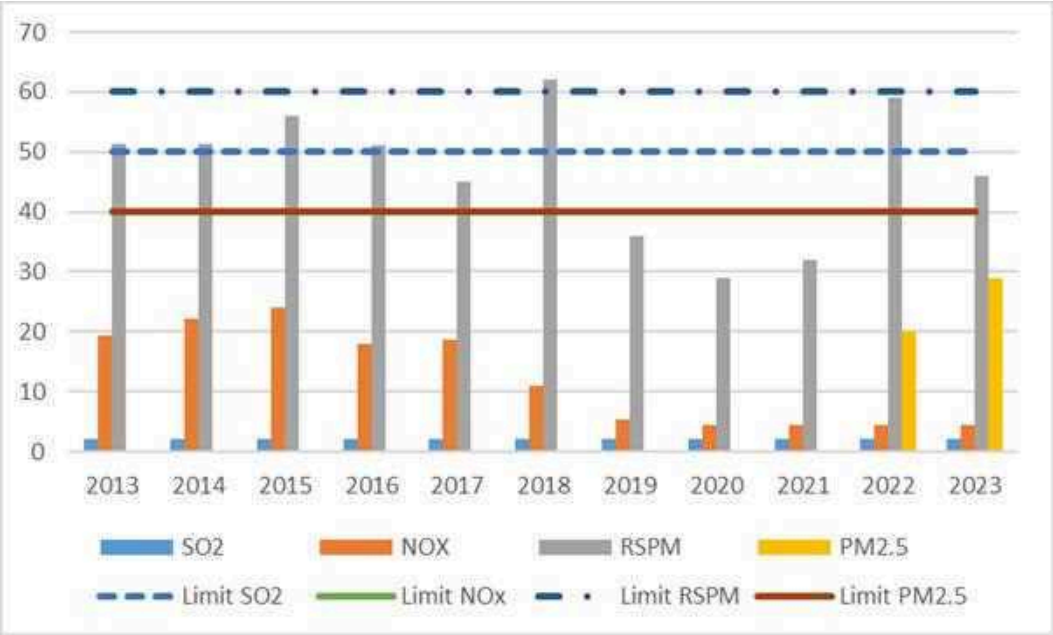
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO2	2.00	2.00	2.00	2	2	2	2	2.00	2	2	2.00	50
NOx	4.87	11.50	13.46	16.57	21.24	18.31	14.95	13.21	15.3	14.51	14.69	40
RSPM	37.46	43.54	43	37	32	31	35	28	31	31	31	60
PM2.5	*	*	*	*	*	*	*	*	*	25	24	40

The air quality data for Kakkancherry, an industrial area in Malappuram district, shows that SO_2 levels have remained consistently low and well within the permissible limit of 50 µg/m³. NOx levels have fluctuated but have stayed consistently below the allowable limit of 40 µg/m³. RSPM levels have been well-controlled, remaining within the 60µg/m³ over the years. PM2.5 levels recorded in 2022 and 2023 are below the permissible limit of 40 µg/m³.

11 KOZHIKKODE DISTRICT

11.1 KOZHIKODE CITY CATEGORY: RESIDENTIAL, RURAL & OTHERS

Trend Analysis 2013 – 2023

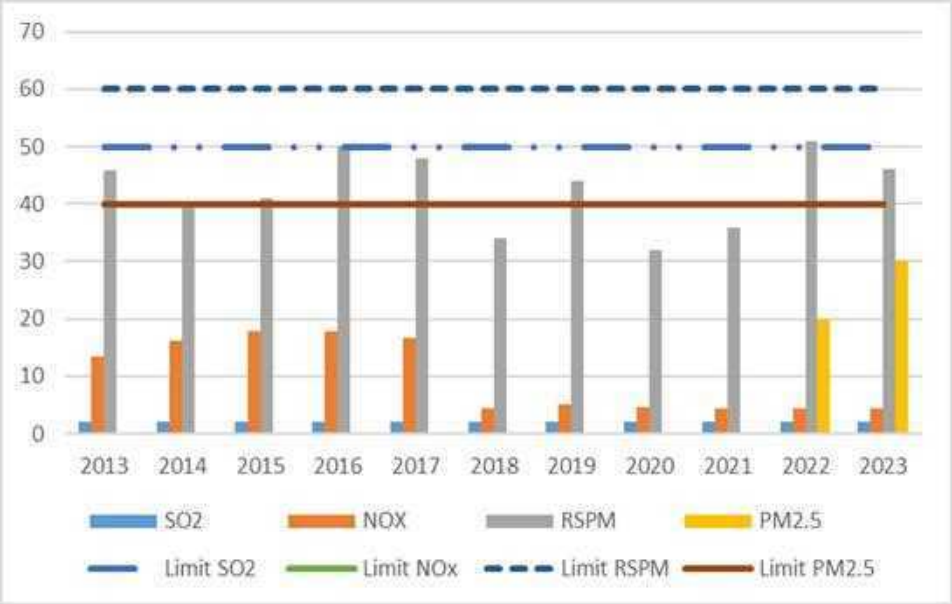


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO2	2.00	2.00	2.00	2	2	2	2	2.00	2	2	2.00	50
NOX	19.41	22.28	24.1	17.87	18.58	10.99	5.4	4.50	4.5	4.5	4.50	40
RSPM	51.33	51.37	56	51	45	62	36	29	32	59	46	60
PM2.5	*	*	*	*	*	*	*	*	*	20	29	40

The air quality data for Kozhikode City, covering residential, rural, and other areas, shows that SO_2 levels have consistently remained well within the permissible limit of 50 µg/m³. NOx levels have significantly decreased over the years, staying well below the 40 µg/m³ in recent years. RSPM levels have fluctuated but have generally remained below the 60 µg/m³. PM2.5 levels recorded in 2022 and 2023 are below the permissible limit of 40 µg/m³.

11.2 NALLALAM **CATEGORY: INDUSTRIAL**

Trend Analysis 2013 – 2023



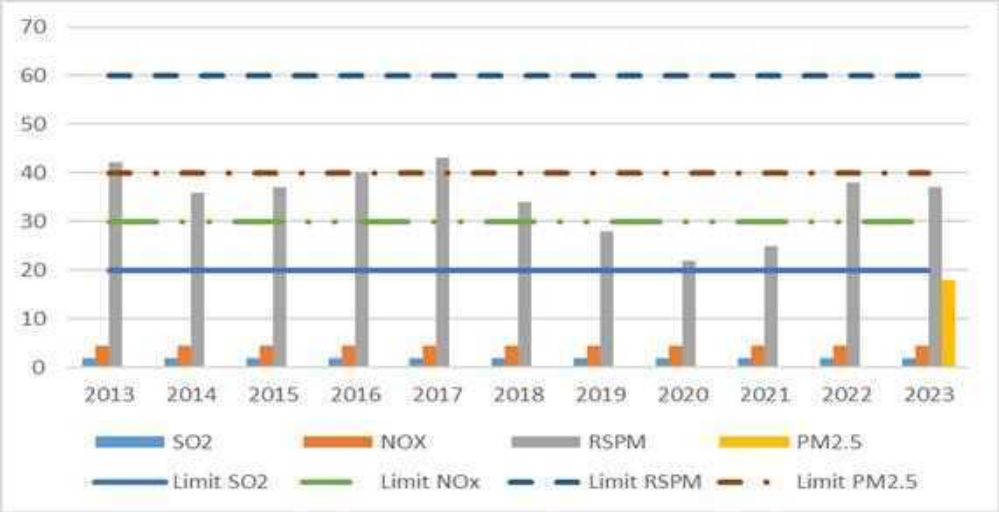
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO2	2.00	2.00	2.00	2	2	2	2	2.00	2	2	2.00	50
NOX	13.48	16.22	17.9	17.76	16.77	4.5	5.1	4.51	4.5	4.5	4.50	40
RSPM	45.75	40.41	41	50	48	34	44	32	36	51	46	60
PM2.5	*	*	*	*	*	*	*	*	*	20	30	40

The air quality data for Nallalam, an industrial area, indicates that SO_2 levels have consistently remained well within the permissible limit of 50 µg/m³. NOx levels have fluctuated but have generally stayed below the 40 µg/m³., with a significant decrease in recent years. RSPM levels have varied but have remained below the 60 µg/m³. PM2.5 levels recorded in 2023, at 30 µg/m³, are below the permissible limit of 40 µg/m³.

12 WAYANAD DISTRICT

12.1 SULTHAN BATHERY CATEGORY: SENSITIVE

Trend Analysis 2013 – 2023

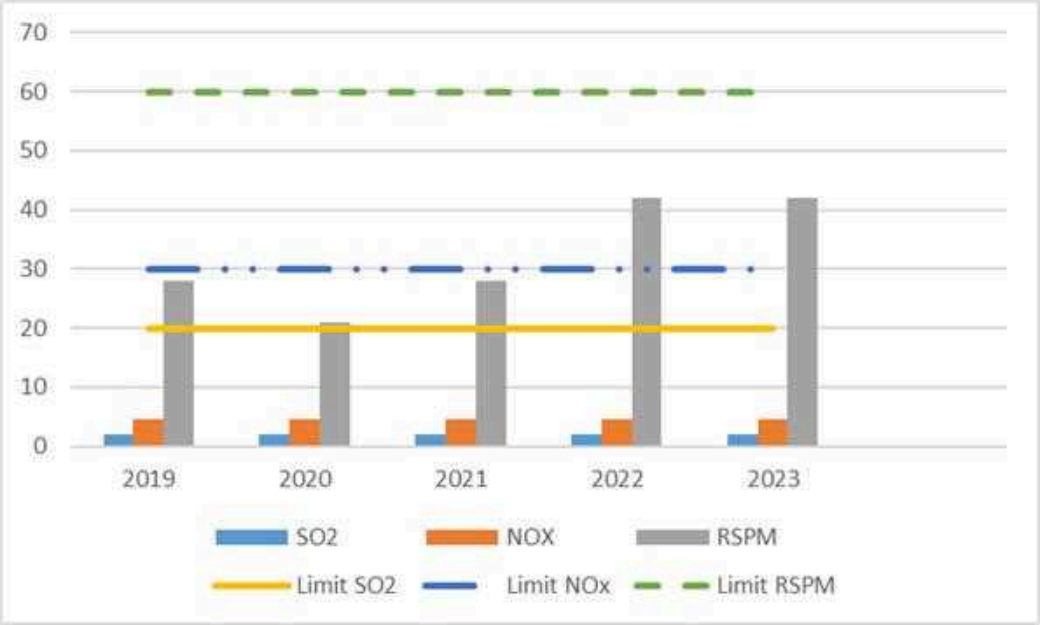


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.00	2.00	2.00	2	2	2	2.00	2.00	2	2	2.00	20
NOX	4.50	4.50	4.50	4.57	4.54	4.5	4.50	4.50	4.5	4.5	4.50	30
RSPM	42.24	36.00	37	40	43	34	28	22	25	38	37	60
PM2.5	*	*	*	*	*	*	*	*	*	*	18	40

The air quality data for Sulthan Bathery, a sensitive area, shows that SO_2 levels have consistently stayed well within the stringent permissible limit of 20 µg/m³. NOx levels have remained stable and well below the 30 µg/m³, indicating effective pollution control measures. RSPM levels have fluctuated, but they have remained well below the 60 µg/m³, with a slight decrease observed in recent years. PM2.5 levels recorded in 2023, at 18 µg/m³, are well within the permissible limit of 40 µg/m³, suggesting that fine particulate pollution is under control in this sensitive area.

12.2 KALPETTA **CATEGORY: SENSITIVE**

Trend Analysis 2019 – 2023



	2019	2020	2021	2022	2023	LIMIT
SO_2	2.0	2.00	2.00	2.00	2.00	20
NOx	4.5	4.50	4.50	4.50	4.50	30
RSPM	28	21	28	42	42	60

The air quality data for Kalpetta, a sensitive area, shows that SO_2 levels have consistently remained within the strict permissible limit of 20 µg/m³. NOx levels have been stable at 4.5 µg/m³, well below the 30 µg/m³. RSPM levels have fluctuated but have generally stayed within the permissible limit of 60 µg/m³.

13 KANNUR DISTRICT

13.1 KANNUR CATEGORY: RESIDENTIAL, RURAL & OTHERS

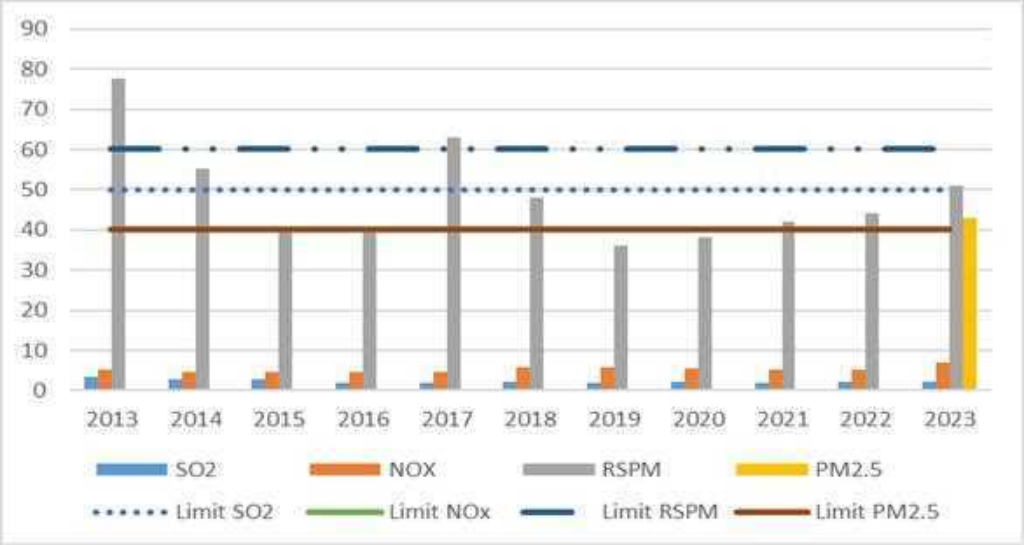
Trend Analysis 2013 – 2023

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	3.75	2.82	2.00	2.00	2.00	2.01	2.04	2.01	2	2.01	2.25	50
NOX	5.05	4.51	4.56	4.53	4.5	6.33	6.93	5.79	5.17	5.2	7.57	40
RSPM	35.63	87.46	63	56	64	51	37	19	37	32	45	60
PM2.5	*	*	*	*	*	*	*	*	*	24	32	40

The air quality in Kannur shows that SO_2 levels have consistently remained within the permissible limit, indicating good control over emissions. NOx levels are within the limit of 40 µg/m³. RSPM levels have fluctuated but remained within the permissible 60 µg/m³ limit. PM2.5 levels are still within the 40 µg/m³ limit.

13.2 MANGATTUPARAMB CATEGORY: RESIDENTIAL, RURAL & OTHERS

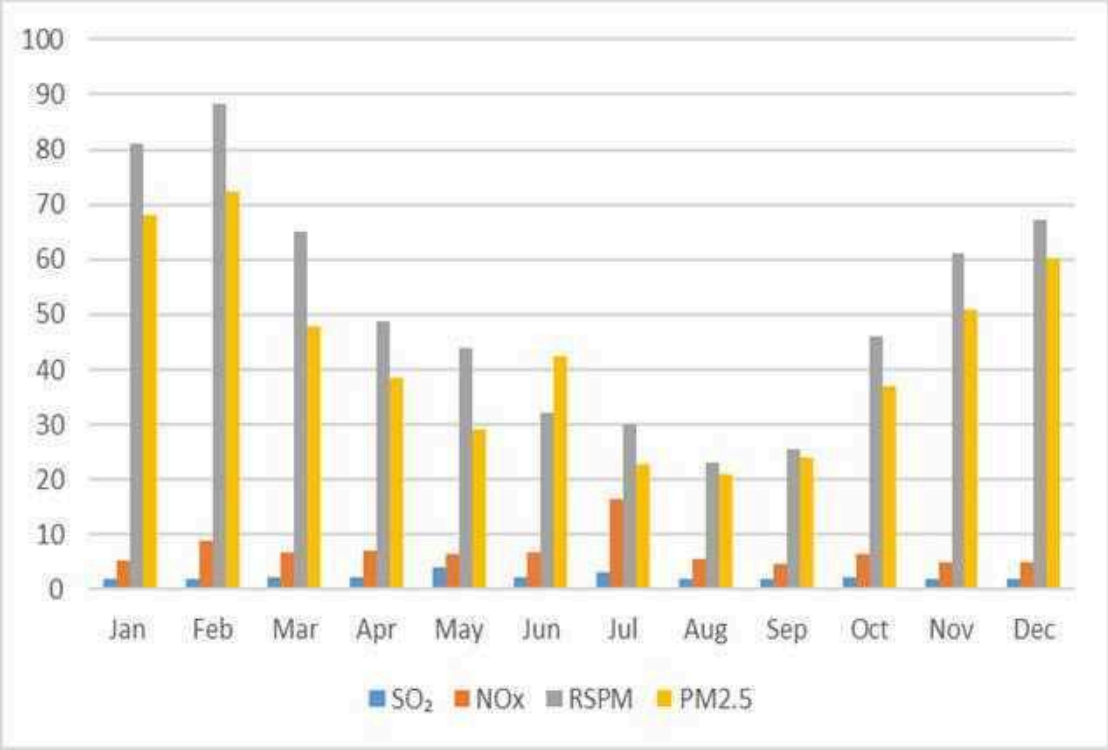
Trend Analysis 2013 – 2023



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	3.47	2.80	2.80	2	2	2.21	2.03	2.35	2.02	2.08	2.35	50
NOX	5.25	4.55	4.50	4.53	4.53	5.93	5.93	5.39	5.17	5.29	6.98	40
RSPM	77.73	55.14	40	40	63	48	36	38	42	44	51	60
PM2.5	-	-	-	-	-	-	-	-	-	-	43	40

The air quality in Mangattumparmb is generally within the acceptable limits, with SO_2 levels consistently below the 50 µg/m³, reflecting effective control of emissions. However, NOx levels shows slight increase. RSPM levels have fluctuated but remained within the 60 µg/m³ limit. PM2.5 level is 43 µg/m³, requiring continued focus on reducing these fine particulate emissions for healthier air quality.

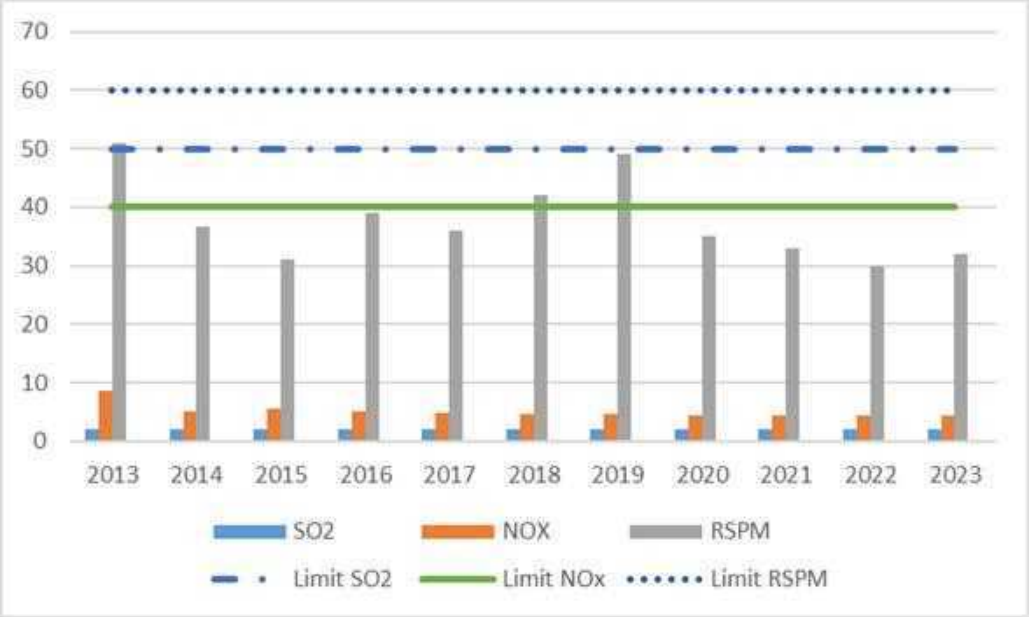
Parameter	SO_2	NOx	RSPM	PM2.5
Jan	2.00	5.18	81.06	68.01
Feb	2.07	8.81	88.45	72.21
Mar	2.17	6.70	64.95	47.98
Apr	2.23	6.93	48.69	38.46
May	4.07	6.41	44.03	29.10
Jun	2.22	6.75	32.12	42.36
Jul	3.22	16.40	30.00	22.75
Aug	2.06	5.47	23.22	20.83
Sep	2.00	4.69	25.58	23.86
Oct	2.11	6.59	46.04	36.82
Nov	2.00	4.91	61.02	50.72
Dec	2.04	4.88	67.02	60.19



14 KASARGODE DISTRICT

14.1 KASARGODE CATEGORY: RESIDENTIAL, RURAL & OTHERS

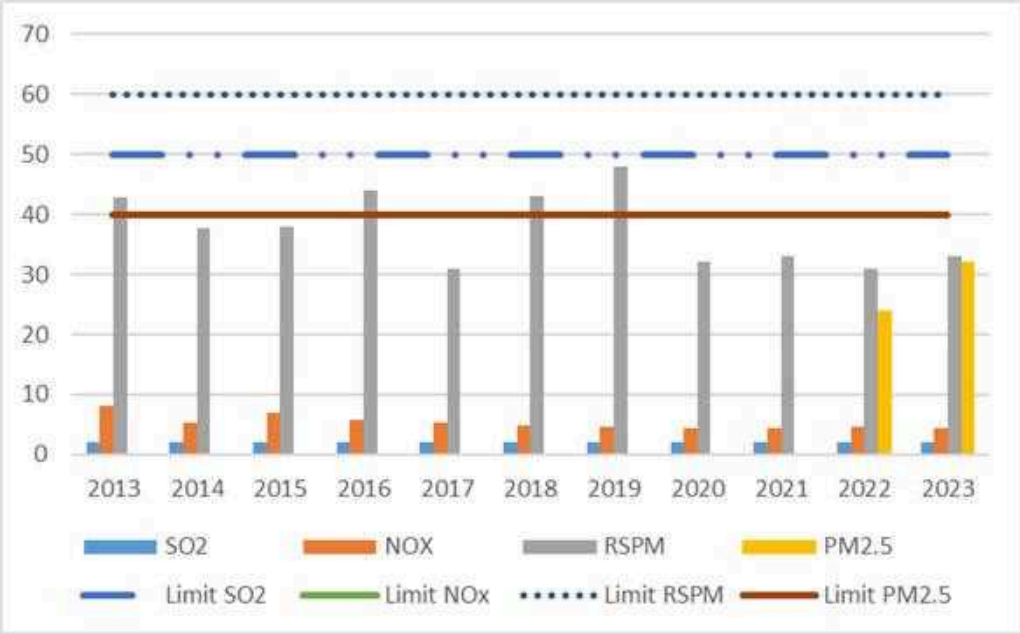
Trend Analysis 2013 – 2023



Kasargode has maintained SO_2 levels well within the prescribed limit of 50 µg/m³, with consistent readings of 2 µg/m³ over the years. NOx levels have remained below the 40 µg/m³. RSPM levels have fluctuated but stayed under the 60 µg/m³ limit, showing moderate variations in particulate matter in the air.

14.2 KANHANGAD **CATEGORY: RESIDENTIAL, RURAL & OTHERS**

Trend Analysis 2013 – 2023



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LIMIT
SO_2	2.00	2.00	2.05	2.14	2.02	2.06	2.02	2.00	2	2	2.00	50
NOx	8.18	5.39	6.99	5.83	5.31	4.83	4.60	4.50	4.5	4.53	4.50	40
RSPM	42.75	37.7	38	44	31	43	48	32	33	31	33	60
PM2.5	*	*	*	*	*	*	*	*	*	24	32	40

Kanhangad has kept SO_2 levels consistently within the prescribed limit of 50 µg/m³, with values hovering around 2 µg/m³ throughout the years. NOx levels have been well below the 40 µg/m³ limit, demonstrating adequate control over nitrogen oxides. RSPM levels fluctuated but remained under the 60 µg/m³ limit, showing moderate variation in particulate matter levels.

3.4. Status of Air quality of the State

Air Quality of Kerala ranges from **Good to Moderate** in the present scenario. Though within the safer limits, particulate matter is emerging as a major concern. The details are available in the Integrated web portal of the Board as well as in the Water and air quality directories published by the Board.

1. Water & air quality directory : https://kspcb.kerala.gov.in/water-and-air-quality-directory
2. Integrated web portal : https://ksrec.in/integrated/Dashboard/index

3.5. Conclusion

State Board is monitoring the ambient air quality at a total of 39 stations in the state under the National Ambient Air Quality Monitoring Programme (NAMP) and the State Ambient Air Quality Monitoring Programme (SAMP). The parameters monitored are Sulphur dioxide (SO_2), Oxides of Nitrogen (NO_x), and Respirable Suspended Particulate Matter (RSPM). Board had already started measurement of PM2.5 at 24 stations in the state and the initialisation process for the measurement of PM2.5 in all the stations.

The annual average concentrations of Sulphur dioxide and Oxides of Nitrogen were within the limit in all monitoring stations during the period from 2013 to 2023. Whereas the RSPM values (PM_{10}) exceeded the limit of 60µg/m³ in some stations.

Actions taken:

DOs of KSPCB were directed to take urgent actions for monitoring stacks in the industrial units and to control pollution from all the processing and boiler stacks in the area.
Motor Vehicle Department was requested to take urgent action to address vehicular pollution.
LSGD was requested to take urgent action to prevent burning of solid waste.

4. EMISSION SOURCES IN KERALA

Air pollution is emerging as a major problem in our cities. Ambient air quality is affected by natural sources and anthropogenic sources, these sources mainly, include:

- **Natural sources**: Wind-blown dust, wildfires, and volcanoes
- **Mobile sources**: Cars, buses, planes, and trains
- **Stationary sources**: Power plants, oil refineries, industrial, non industrial units and construction and demolition sources
- **Area sources**: Agricultural areas, cities, and burning of waste & dry leaves

Primary pollutants are emitted directly from a source, while secondary pollutants are formed when primary pollutants react in the atmosphere. Primary pollutants include particulate matter emitted from power plants, construction sites, and vehicle traffic. Lead is another primary pollutant released into the air from leaded petrol. Secondary pollutants include ozone, acid rain, and peroxyacetyl nitrates (PANs).

4.1. Vehicular emission

Vehicular emissions are a major source of air pollution globally, contributing to various environmental and health issues. These emissions include harmful pollutants such as nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO), hydrocarbons (HC), sulfur dioxide (SO2), and carbon dioxide (CO2). The rise in the number of vehicles and the increased demand for road transport has led to stricter emission standards and regulatory measures worldwide.Vehicular emissions can be categorized into two main types:

- **Exhaust emissions**: Pollutants emitted from the vehicle's exhaust system, mainly including CO, NOx, HC, PM, and CO2.

- **Non-exhaust emissions**: These include wear and tear from tires, brakes, road dust, and the evaporation of volatile organic compounds (VOCs) from fuel systems.

4.1.1. Global Emission Standards

Countries around the world have implemented various emission standards to control vehicular pollution. These standards focus on limiting the levels of pollutants from both light-duty and heavy-duty vehicles. Different standards are

1. European Union - Euro Standards
2. India - Bharat Stage (BS) Standards
3. United States - EPA and CARB Standards
4. China - China VI Standards

4.1.2. India - Bharat Stage (BS) Standards

India regulates vehicular emissions through a series of standards known as Bharat Stage (BS) standards, which are based on the European Union's Euro emission nor**ms**. These standards aim to reduce air pollutants from vehicles by setting progressively stringent limits on emissions of nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO), and hydrocarbons (HC). The introduction of these standards has been instrumental in India's fight against rising air pollution, especially in urban areas where vehicular emissions are a major source of pollution.

The Bharat Stage standards were first introduced in India in 2000, following the Supreme Court of India's directive to address growing concerns about urban air quality. Initially, BS-I standards were implemented, which were aligned with Euro I standards. Over time, the Indian government has adopted more stringent versions of the Bharat Stage standards, with each stage aimed at reducing emissions from vehicles by incorporating advanced technologies such as catalytic converters, diesel particulate filters (DPFs), and selective catalytic reduction (SCR) systems.

The progression of standards has been as follows:

- **BS-I (2000)**: Aligned with Euro I standards, introduced as a basic step toward controlling vehicular emissions.
- **BS-II (2005)**: Aligned with Euro II, BS-II introduced stricter limits on emissions of PM, NOx, and CO. It was first implemented in metropolitan cities, followed by nationwide enforcement.

- **BS-III (2010)**: Equivalent to Euro III standards, BS-III mandated significant reductions in NOx and HC emissions. This was the first nationwide rollout of advanced emissions regulations.
- **BS-IV (2017)**: Based on Euro IV standards, BS-IV further tightened the emission limits, particularly for diesel engines, which are major contributors to NOx and PM emissions. BS-IV regulations were implemented across the country after being introduced in select urban centers.

BS-VI Implementation

India made a significant leap in 2020 by skipping **BS-V (equivalent to Euro 5)** and directly moving to **BS-VI** standards, equivalent to Euro 6, making this shift one of the most significant policy changes in India's emission regulation history. The primary motivation behind this transition was the urgent need to address rising pollution levels, particularly in major cities like Delhi, where air quality frequently reached hazardous levels due to vehicular emissions and other sources.

The below table offers Associate in Nursing insight into the modification within the permissible emission levels of BS6 vehicles compared to BS4 vehicles.

Fuel Type	Pollutant Gases	BS6 (BSVI)	BS4 (BSIV)
Petroleum Distillate Vehicle	Nitrogen Oxide (NOx) Limit	60 mg	80 mg
	Particulate Matter (PM) Limit	4.5 mg/km	-
Diesel Fuel Vehicle	Nitrogen Oxide (NOx) Limit	80 mg	250 mg
	Particulate Matter (PM) Limit	4.5 mg/km	25 mg
	HC + NOx	170 mg/km	300 mg

Indian emission standards (4-wheeled vehicles)

Standard	Reference	Year	Region
India 2000 / Bharat Stage I	Euro 1	2000	Nationwide
Bharat Stage II	Euro 2	2001	NCR, Mumbai, Kolkata, Chennai
		2003	NCR, 14 Cities
		2005	Nationwide
Bharat Stage III	Euro 3	2005-04	NCR, 14 Cities
		2010	Nationwide
Bharat Stage IV	Euro 4	2010	NCR, 14 Cities
		2017	Nationwide
Bharat Stage VI	Euro 6	2018	Delhi
		2019	NCR
		2020	Nationwide

In recent years, governments and regulatory bodies have introduced stringent standards to reduce vehicular emissions. These standards are designed to limit the quantity of harmful pollutants released from vehicles into the atmosphere.

Despite advances in technology and stringent emission standards, there are challenges in Reducing Vehicular Emissions:

- **Old Vehicles**: Older vehicles continue to operate in many regions, contributing to higher emissions due to outdated technology.

- **Enforcement**: Proper enforcement of standards remains a challenge, particularly in developing countries.
- **Urbanization**: The rapid pace of urbanization is increasing the number of vehicles on the road, making it difficult to curb emissions effectively.
- **Affordability**: The higher cost of low-emission vehicles and electric vehicles remains a barrier for mass adoption, especially in lower-income countries.

Kerala has a vehicle density of 62 vehicles per kilometre of road. This is a result of a significant increase in the number of vehicles in the state, from 60.7 lakh in 2011 to 148.5 lakh in 2021. In March 2016, Kerala had 305 vehicles per 1,000 people. This is higher than the national average of 18 vehicles per 1,000 people. Kerala has a road density of 614 kilometres per 100 square kilometres, which is more than three times the national average. Two-wheelers make up two-thirds of the vehicles in Kerala. The motor transport sector is a vital part of Kerala's economy, with an annual growth rate of over 10% for the past two decades.

Vehicular emissions remain a significant environmental concern globally, but there has been progress in reducing their impact through stringent emission standards and technological innovation. The global shift towards electric vehicles and cleaner energy sources is expected to play a key role in further reducing vehicular emissions in the future. However, continued efforts are required to enforce regulations, promote the use of cleaner technologies, and encourage sustainable transportation practices. In the long term, achieving global targets for emissions reduction will depend on a collaborative effort between governments, industries, and consumers

4.2. Industrial Emission

Industrial emissions are pollutants released into the air, water, and land from industrial activities, such as manufacturing, processing, and energy production. Based on the pollution potential, industrial units are classified as

- **Red Category**: High pollution potential requiring stringent regulatory controls.
- **Orange Category:** Moderate pollution potential with specific environmental guidelines.
- **Green Category**: Low pollution potential with minimal regulatory oversight.
- **White Category**: Non-polluting industries.

These industries based on the capital investments are classified as:

- Small : Capital investment less than 5 crore
- Medium : Capital investment from 5 crore to 10 crore
- Large : Capital investment more than 10 crore

The source of air pollution in industries are through the stacks of processing, D.G sets & boilers. Fugitive emission occurs in the units like crushers , quarry and paint units. Majority of the industries in Kerala are small scale industries, under the category of plywood, cashew factories, rendering plants and brick kilns.

The major large scale industries are mainly situated in Ernakulam district, which includes FACT Ltd., Petrochemical Division, Eloor ; The Fertilisers And Chemicals Travancore limited, Eloor ; Cochin Minerals and Rutile Ltd., Industrial Development Area, Edayar; TMS Leathers, industrial development area, Edayar; Bharat Petroleum Corporation Limited (BPCL); Travancore Cochin Chemicals,Eloor; Hindustan Organic Chemicals (HOC). List of red category large scale industrial units were taken and various types of industrial units like hospitals, flats, hotels, shopping malls and IT parks were excluded , other 127 units were plotted. This include 8 units in Thiruvananthapuram, 5 units in Kollam, 6 units in Alappuzha, 3 units in Pathanamthitta, 4 units in Kottayam, 3 units in Idukki, 55 units in Ernakulam, 15 units inThrissur, 18 units in Palakkad, 1 unit in Malappuram, 4 units in Kozhikode, 2 units in Wayanad and 3 units in Kannur. Details of industrial units and map of red category large scale industrial units are attached as **Annexure I.**

The other major are The Indian Rare Earths Ltd. (IRE); Kerala Minerals and Metals Ltd. (KMML) at Chavara (Kollam); The Travancore Titanium Products (TTP) at Veli (Trivandrum); Nita Gelatin, Koratty, Thrissur; Palm Fibre (INDIA) private ltd, Pathirapally, Alappuzha; Kerala Agro Machinery Corporation Limited, Ernakulam; Travancore Mats and Matting Pvt. Ltd., Cherthala ; Carborundum Universal Limited, SEZ, Kalamassery, Kochi; Kozhikode Diesel Power project, Kozhikode. Common Biomedical Waste Treatment and Disposal Facility is situated at Kanjikode, Palakkad and at Ambalamedu, Kochi, incinerators are provided in these facilities.

4.2.1. 17-Category and Grossly polluting Industries in Kerala

The Central Pollution Control Board (CPCB) has categorized 17 industries as highly polluting and has directed them to install online monitoring systems. The purpose of this is to encourage self-regulation and monitoring by the industries themselves. The Board issues consent

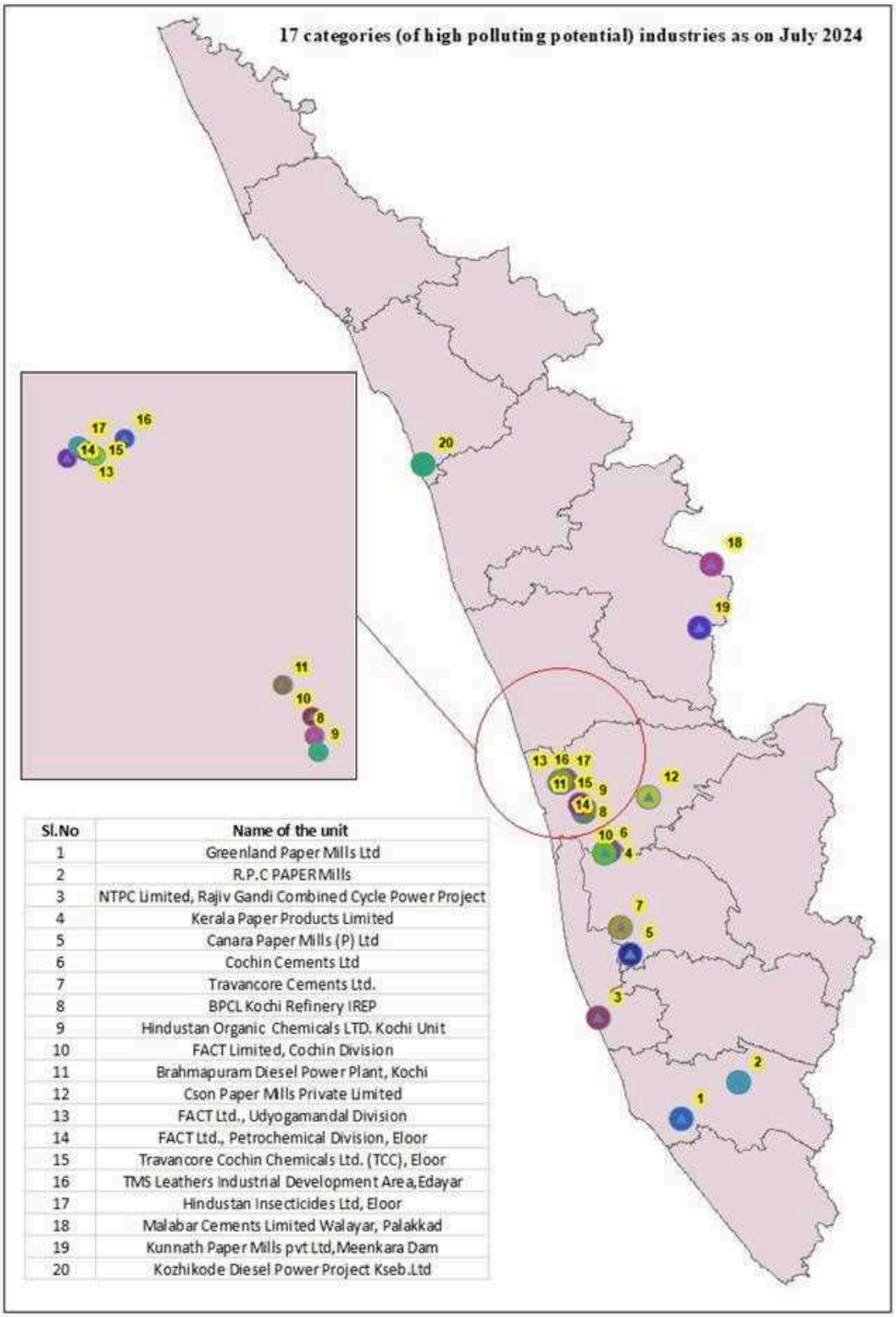
to establish and consent to operate to the units under Air and Water act and Environment Protection act and the conditions for regulating emission included in the consent order and its compliance is monitored by the KSPCB.

20 industrial units are included in 17 category industries of which 4 industrial units are not operational; the remaining 16 units are operational. These include 6 industries in paper and pulp category, 3 thermal power plants, 3 fertilizer units, 3 cement industries, and one unit each under chlor alkali, oil refineries, pesticides, petrochemicals and tanneries.

Grossly polluting industries (GPIs) are those that discharge wastewater more than 100,000 litres per day or use hazardous chemicals. In our state 23 industrial units are included in GPI, of which only 21 industrial units are operational. Some of the industrial units that are included in 17 category also come under GPI. GPI industrial units that comes under 17 category include, Fact Ltd., Udyogamandal Division; Fact Ltd., Petrochemical Division ; Fertilisers And Chemicals Travancore limited, Ambalamedu; CSON Paper Mills Pvt Ltd, Muvattupuzha; Travancore Cochin Chemicals Ltd. (TCC), Eloor; TMS Leathers, Edayar; Hindustan Insecticides Ltd, Eloor and Kunnath Paper Mills Pvt, Palakkad. Other units are Greenland Paper Mills Ltd, Kollam; R.P.C PAPER Mills, Punalur, Kollam; NTPC Limited, Alappuzha; Kerala Paper Products Limited, Kottayam; Canara Paper Mills (P) Ltd, Kottayam; Cochin Cements Ltd, Mevelloor, Kottayam; Travancore Cements Ltd., Nattakom, Kottayam; BPCL kochi refinery irep, Ambalamugal, Ernakulam; Hindustan Organic Chemicals LTD. Kochi Unit, Ambalamugal, Ernakulam; Brahmapuram Diesel Power Plant, Kochi; Cson Paper Mills Private Limited, Muvattupuzha, Ernakulam; Malabar Cements Limited Walayar, Palakkad; Kozhikode Diesel Power Project Kseb.Ltd , Kozhikode; Kerala Minerals & Metals Ltd ,Chavara, Kollam; Sea Food Park, Aroor, Alappuzha; Malabar Cements Ltd, Cherthala, Alappuzha; BPCL Kochi Refinery, Ernakulam; Nitta Gelatin India Ltd, Gelatin Division, Ernakulam; Products Diary, MILMA, Ernakulam; Indian Rare Earths Ltd, Eloor, Ernakulam; Sud Chemie India Private Limited, Edayar, Ernakulam; Cochin Minerals And Rutile Ltd.,Ernakulam; Nita Gelatin, Koratty, Thrissur; Augustan Textile Colours, Malampuzha Road, Palakkad; United Breweries Limited, Kanjikode West, Palakkad; Kozhikode Dairy, Kunnamangalam, Kozhikode; Parisons Agrotech Pvt Ltd, Kozhikode and Freshcut Organic Products Pvt Ltd, Kozhikode.

List of 17 Category Industries and Grossly Polluting Industries in Kerala (as on 30/07/2024) are attached as **Annexure II.**

Map showing 17 category industries and Grossly Polluting Industries is attached.



Sl.No	Name of the unit
1	Greenland Paper Mills Ltd
2	R.P.C PAPER Mills
3	NTPC Limited, Rajiv Gandi Combined Cycle Power Project
4	Kerala Paper Products Limited
5	Canara Paper Mills (P) Ltd
6	Cochin Cements Ltd
7	Travancore Cements Ltd.
8	BPCL Kochi Refinery IREP
9	Hindustan Organic Chemicals LTD. Kochi Unit
10	FACT Limited, Cochin Division
11	Brahmapuram Diesel Power Plant, Kochi
12	Cson Paper Mills Private Limited
13	FACT Ltd., Udyogamandal Division
14	FACT Ltd., Petrochemical Division, Eloor
15	Travancore Cochin Chemicals Ltd. (TCC), Eloor
16	TMS Leathers Industrial Development Area,Edayar
17	Hindustan Insecticides Ltd, Eloor
18	Malabar Cements Limited Walayar, Palakkad
19	Kunnath Paper Mills pvt Ltd,Meenkara Dam
20	Kozhikode Diesel Power Project Kseb.Ltd

4.2.2 Online Emission Monitoring System

Online emission monitoring system is installed in the stack of major industrial units and the data is connected to the Board's server. Analyzers are installed on chimneys and stacks, and at the outlets of sewage and effluent treatment plants, The analyzers generate data on emissions at regular intervals ,The data is transmitted to a remote server over the internet, The data is displayed on a web portal and If the pollutant levels exceed the prescribed limits, an alert is sent to the industrial unit, SPCB, and CPCB.

4.2.3 Eloor Edayar Industrial Area

The Eloor-Edayar Industrial Area in Ernakulam district, is located along the river Periyar. In Edayar industrial area 284 industrial units and Eloor industrial area 65 units are established. In Eloor, there are four large scale industrial units, they are FACT-UD, FACT-PD, Indian Rare Earths Limited (IREL) and Travancore Cochin Chemical(TCC). Other industrial units in this area in the small scale sector include food processing units,CO_2 filling units, automobile engineering units, paper, rayon, rubber, textiles, and plywood manufacturing.

Major industrial units in Edayar include, Sud-chemie, TMS Leathers and Cochin Minerals and Rutile Ltd other industrial units are majority in the small scale sectors including, activated carbon production (3 units), rendering units (16 units), formaldehyde resin unit (10 units), bone meal/rendering unit (16 units), paint unit/thinner etc (3 units) , rubber industries (5 units), electroplating/ powder coating units (11 units), oleo resin units (2 units) and ready mix/concrete allied/ sand unit (6 units).

.List of industries in Eloor- Edayar area is attached as **Annexure III.**

4.2.4. Plywood industries

Plywood can be made of various thicknesses by gluing as many as veneer layers required based on the thickness. In the Plywood Industry energy is consumed in the form of thermal energy and electrical energy. Mainly plywood industries are located in Ernakulam, Kannur and Kozhikode districts. List of plywood industries is attached as **Annexure IV.**

In Ernakulam large clusters of plywood industries are located in the Perumbavoor area, major clusters are included in the panchayats of Vengola, Asamannoor, Paipra and Rayamangalam. In Vengola grama panchayath a study was conducted in the 23 wards by ABC Techno Labs in 2015, it was found that a total of 275 industries were established in these wards, majority of the industries were plywood units. The primary emissions from the manufacture of plywood include particulate matter PM10 and PM2.5 from log debarking, plywood trimming, sanding and from heating systems. Organic compounds like formaldehyde arise from gluing and hot pressing. Fuel combustion for heating system generates carbon monoxide (CO), carbon dioxide(CO2), sulphur dioxide (SO2) and nitrogen oxide (NOX) emissions. Presence of formaldehyde in air emission warrants adequate air pollution control devices in combination of cyclone separator, bag filter/ wet scrubber. The increased concentration of formaldehyde was observed mainly because of the fuel used in the Boiler.

When mapping of industries in Asamannoor grama Panchayath was done, clusters were identified using GIS SOFTWARE, based on these industries that make a cluster in a 500m radius. Identified clusters are :

1) Kottachira Cluster - Number of industries -28
2) Odakkali Cluster - Number of industries -14
3) Nooleli Cluster - Number of industries - 16
4) Methala – Number of industries – 6

When mapping of industries in Paipra gramaPanchayath was done, clusters were identified using GIS SOFTWARE, based on these industries that make a cluster in a 500m radius. Identified clusters are :

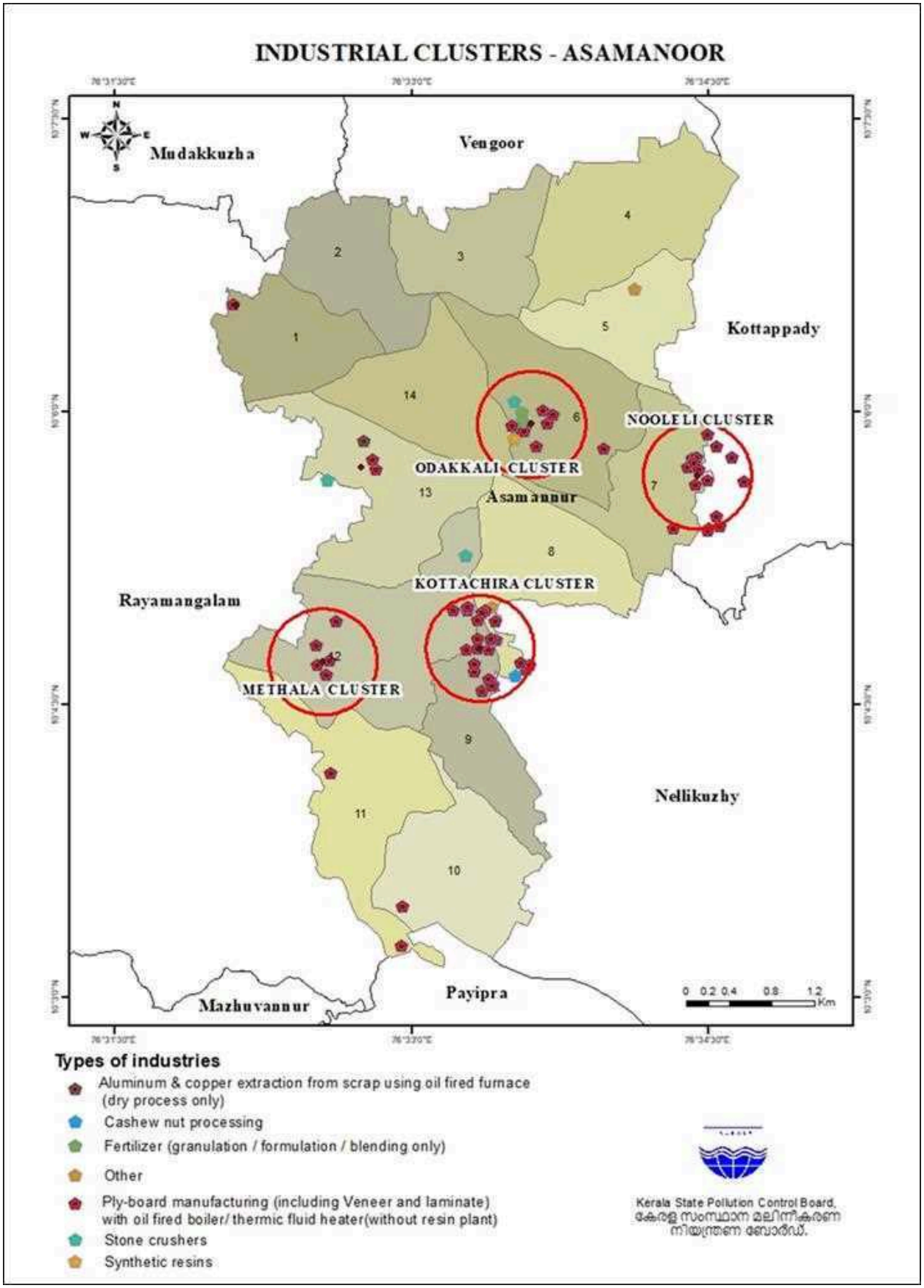
1) Manary Cluster - Number of industries -24

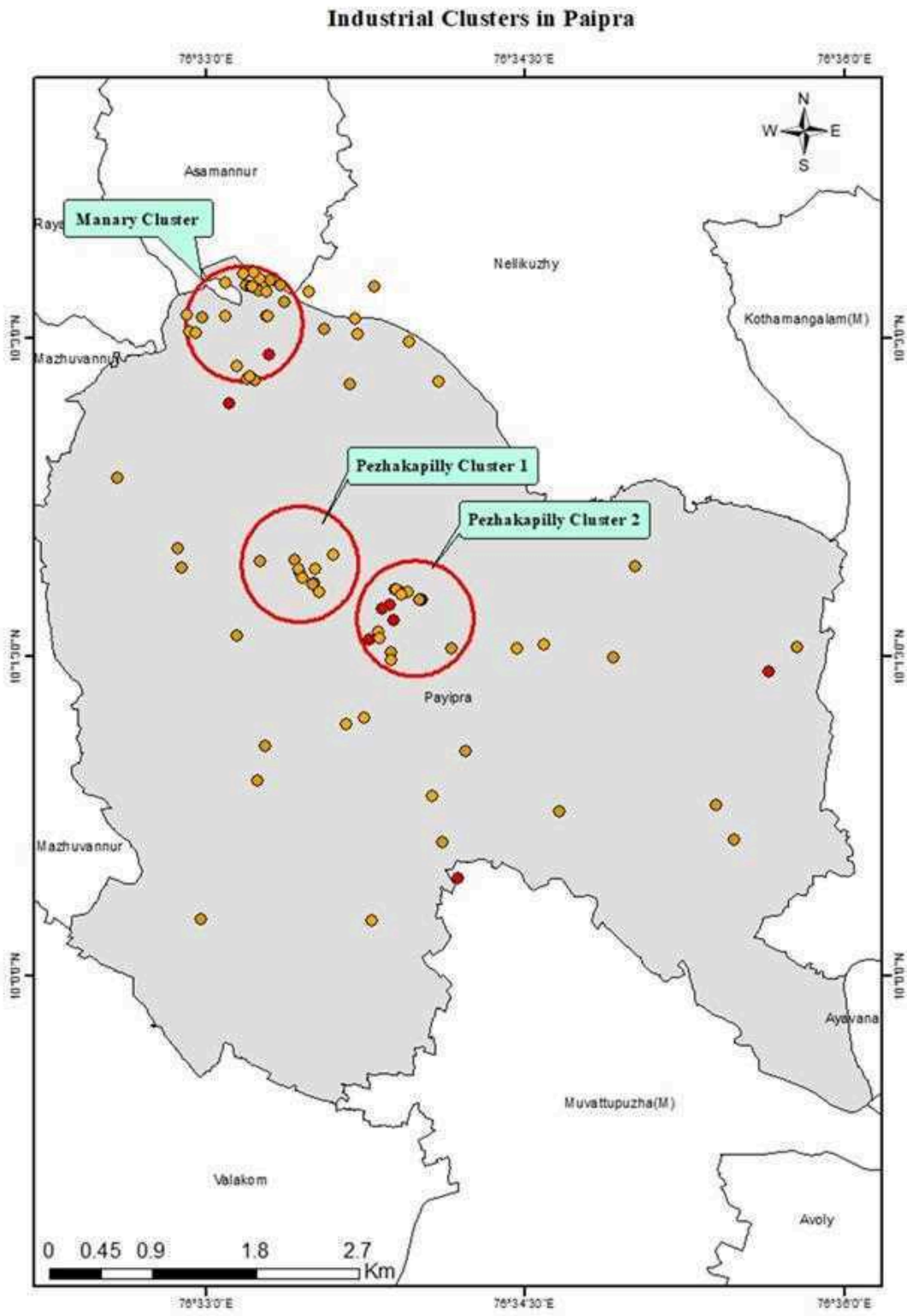
2) Pezhakapilly Cluster 1 - Number of industries -12

3) Pezhakapilly Cluster 2 - Number of industries – 15.

Plywood industries and stone crushers are the major type of industrial units included in the clusters.

Map showing industrial clusters in Asamannoor and Paipra Panchayath is attached.


INDUSTRIAL CLUSTERS - ASAMANOOR
Mudakkuzha
Vengoor
Kottappady
Asamannur
NOOLELI CLUSTER
ODAKKALI CLUSTER
KOTTACHIRA CLUSTER
METHALA CLUSTER
Rayamangalam
Nellikuzhy
Payipra
Mazhuvannur
1
2
3
4
5
6
7
8
9
10
11
12
13
14
0 0.2 0.4 0.8 1.2 Km
Types of industries
Aluminum & copper extraction from scrap using oil fired furnace (dry process only)
Cashew nut processing
Fertilizer (granulation / formulation / blending only)
Other
Ply-board manufacturing (including Veneer and laminate) with oil fired boiler/ thermic fluid heater(without resin plant)
Stone crushers
Synthetic resins
Kerala State Pollution Control Board.


Industrial Clusters in Paipra
76°33'0"E
76°34'30"E
76°36'0"E
N
W
E
S
Asamannur
Manary Cluster
Nellikuzhy
Kothamangalam(M)
Mazhuvannur
Pezhakapilly Cluster 1
Pezhakapilly Cluster 2
Payipra
Mazhuvannur
Ayavana
Muvattupuzha(M)
Valakom
Avoly
0 0.45 0.9 1.8 2.7
Km

4.2.5. Steel industries

India is the second largest producer of steel in the world after China, with a production capacity of approximately 110 million metric tons per annum. Palakkad district houses the second largest industrial area of Kerala- Kanjikode, situated in Pudusseri Panchayath of Palakkad Taluk. The Kanjikode industrial area has the largest concentration of iron and steel industries in the state. There are twenty-four MSME units of iron and steel industries in the Kanjikode area. They are of two major types- ingot units with induction furnaces and rerolling units with reheating furnaces. There are 13 ingot units and 11 rerolling units located in this area. The air pollution control system adopted by the units include bag filters, cyclonic separators, wet venturi scrubbers, etc. Bag filters are the major air pollution control devices that are being adopted by majority of the industries. Few industries also have wet scrubbers including venturi scrubbers and spray towers for the control of gaseous air pollutants as well. Adoption of Standard Operating Procedures and periodic training to staff on the maintenance of Air Pollution Control Devices can have significant positive impact on the overall environmental quality both inside the industry and outside.

Detailed List of steel industries (Ingot units and Rerolling units) in Kanjikode Industrial area of Palakkad district is attached as **Annexure V.**

4.2.6. Cashew nut industries

There are about 1000 cashew nut processing plants in Kerala. In addition to processing of locally grown cashew nuts, kernels are also imported from African countries and Indonesia for processing in Kerala.

These industries cause air pollution from roasting and drying processes. The emissions contain oily vapours, soot and combustion products. Water pollution is caused by discharge of quenching water, which contains oil.

Environmental improvement measures target at:

- Improvement of the efficiency of combustion and reduction of air pollutant emissions;
- Full utilization of waste products, such as oil, shells and peels;

- Treatment of wastewater.

List of cashew industries are attached as **Annexure VI.**

4.2.7. Used oil/ Waste oil re-processing/ recycling units

There are six recyclers of used oil/waste oil in Kerala. The details of the units are as follows:

Recycler of Used Oil/ Waste oil in Kerala (Data as on 09.07.2024)

Sl No.	Address of Unit	Authorized for	Authorized Capacity	Consent Valid Upto	Remarks
1	APJ Refineries Private Limited, New Industrial Development Area, Kanjikode, Palakkad- 678621	Used oil	40 MT per day	30/10/2026	----
		Waste Oil	24 MT per day		
2	Swaraj Bio Fuel Energy, VIII/1256, NIDA, Road No. A7, Kanjikode, Palakkad- 678621	Used Oil	1800 MT per year	28/02/2029	----
		Waste Oil	1800 MT per year		
3	JJ Refineries, Plot 309/2,3,360/2. NIDA, Kanjikode P O, Palakkad, Kerala-678621	Used Engine Oil	9490 KL per year	19/11/2028	----
		Used Industrial Oil	10950 KL per year		
		Waste Oil	10950 KL per year		
4	Petroliv Petroleums (Angels Group), Sy.No.676/87 G, Erikulam P.O,	Used Oil	1080 KL per year	28/02/2029	----

	Madikkai, Nileshwar, Kasaragod-671314	Waste Oil	1080 KL per year		
5	Cee Jee Lubricants, VI/592, IDA Edayar, Aluva, Ernakulam-683502	Used Oil	3000 KL per year	30/06/2028	Currentl y closed.
		Waste Oil	6000 KL per year		
6	Excel Petrochemicals, Industrial Development Area, Edayar, Muppathadom P.O.	Used Oil	1200 KL per year	30/06/2028	----

4.2.8. Brick Kilns

Brick making is a very important sector in the rural area of Kerala. Most of the industries are of small size. Most plants use firewood as a fuel for heating their kilns. The major environmental impact of this sector entails the excavation of clay, which is often done in an unorganized and unplanned manner. Environmental improvement may target reduction of fuel consumption, inventory and evaluation of existing clay excavation sites and preparation of a system for control and management of clay excavation.

Ministry of Environment and Climate Change vide Notification dated 22/02/2022 had made Rule amendment with respect to brick kilns. It was instructed by the Ministry that the standards for particulate matter in stack emission and minimum stack height specified in the Notification shall be strictly addressed to. All new brick kilns shall be allowed only with zig zag technology or vertical shaft or use of piped natural gas as fuel in brick making. The existing brick kilns which are not following as above shall be converted to, within a period of two years.

The Ministry vide Notification dated 15.12.2023 further informed that the existing brick kilns shall be converted/adopt to the new technology within a period of one year w.e.f. 23.02.2023.

In accordance with the MoEF & CC notification, the consent of existing temporary or seasonal brick kilns can be renewed up to 22.02.2025 subject to compliance of all the conditions in notification and prevailing circulars.

Brick kilns are mainly located in the districts of Kollam, Kottayam, Ernakulam, and Palakkad. Most of these kilns in Kerala are temporary or seasonal establishments, and use firewood as fuel. (as per inventory dated 06/11/2024)

Seasonal/Temporary Brick Kilns: 110 nos

Permanent Brick Kilns:19 nos

Detailed List of Brick kilns is attached as **Annexure VII.**

4.2.9. Stone Crushers

Stone crushers play a crucial role in Kerala's construction and infrastructure sectors, producing aggregates and crushed stones required for building roads, bridges, and other structures. Most of the stone crushers are located in Ernakulam (159), Malappuram (89), Kollam (85), Kozhikode(80) and Kottayam (69).The Board has issued Circulars mandating pollution control measures,site suitability,standards for establishment/expansion of crushers. The criteria includes the following;

- There should be a minimum clear distance of 150m from the centre of the proposed primary crusher unit to the periphery of the structure of any residence, public building or place of worship
- There should be a minimum clear distance of 100 m from the centre of the crusher of one industry to the centre of crusher of another industry
- Area requirement of Stone crushing premises : Minimum 2.5 acres (1 hectare)
- Other control measures include 23cm brick wall for crusher machine,enclosure for all other dust/noise generating parts,water sprinklers at transfer points,road wetting,tarred/concreted internal roads,adequate water storage tanks and source of water,settling tank for recirculating wash water. List of stone crushers is attached as **Annexure VIII**.

4.3. Waste Management

4.3.1 Solid Waste Management

The State Government had notified by-laws for solid waste management as per the provisions of the Solid Waste Management Rules, 2016. The use of single use plastic products has been banned in the State since 2019. The Local Self Government Institutions (LSGIs) of the State are utilizing the service of authorized agencies like Haritha Karma Sena for door to door collection of solid waste. These efforts have reduced illegal waste burning and littering. The monitoring and enforcement system however needs strengthening inorder to prevent illegal dumping of biodegradable waste on vacant land, forest and water bodies.

The state has taken strong measures to implement effective waste management systems and enforce regulations designed to streamline the operations. Acknowledging the urgent need for sustainable waste practices, a comprehensive strategy has been developed that encompasses infrastructure improvements, public education initiatives, and the establishment of strict policies. To support this, the Government of Kerala enacted Amendment Ordinances to the Kerala Municipality Act and the Kerala Panchayat Raj Act on December 8, 2023.

Under the revised legislation, all citizens are required to submit segregated waste to their local body or to an authorized agency for proper scientific processing. Local bodies may also face fines for failing to act in accordance with state government directives. Furthermore, institutions and commercial establishments are now obligated to keep their premises litter-free and ensure that all waste generated is disposed of properly. These activities are closely monitored at both the local and state levels to ensure effective implementation.

In the state, a total quantity of 10076.17 TPD waste is being generated as per present population, in which 3011.23 TPD of waste is produced in urban and 6561.12 TPD in rural areas, respectively, approximately 73% of the waste generated is organic material and in the remaining portion, 22% is inorganic waste and 5% reject material. Out of 10076.17 TPD waste generated in the state, 7398.64 TPD is biodegradable waste, 2173.72 TPD is non biodegradable waste and 503.81 TPD is inert.

The State's policy on biodegradable waste management adopts a decentralized approach, emphasizing source-level treatment of biowaste generated by households. This policy encourages the use of composting devices and biogas plants at the household level to process organic waste, thereby reducing the burden on centralized waste management systems. To address gaps where households may lack capacity, community facilities are implemented to manage surplus waste. This integrated approach promotes sustainability by minimizing transportation needs, reducing landfill waste, and fostering the production of renewable resources like compost and biogas, while also encouraging community participation and local solutions.

Dry waste generated from households and institutions is collected and transported to Material Collection Facilities (MCFs) or Resource Recovery Facilities (RRFs), where it is segregated into recyclable and non-recyclable waste. The recyclable waste is sent to recycling units, while non-recyclable waste is directed to co-processing facilities, such as cement plants, for energy recovery. After separating biodegradable and non-biodegradable waste from the total waste generated, the remaining portion, known as inert waste, is utilized to fill low-lying areas, offering an environmentally sustainable method of disposal.

4.3.2. Biodegradable Waste Management

For biodegradable waste management in the state, various composting devices and biogas units are utilized to manage wet waste at its source. The compost produced from household waste treatment is used as fertilizer for gardening in individual 4 residences. Approximately 80% of the total biodegradable waste generated is managed at the source, while the remaining 20% is handled by community-level facilities operated by local bodies.

Depending on land availability, a range of medium-capacity decentralized composting facilities—such as aerobic compost units, organic waste converters, windrow plants, and biomethanation facilities—has been widely established across Kerala. The compost generated from community facilities is branded and marketed as fertilizer to local farmers through the Krishi Bhavans within the local body. Additionally, centralized facilities, like compressed biogas (CBG) plants, are being planned and implemented to manage waste more economically.

Construction of a CBG plant in Ernakulam district has already begun, and six other projects are in the planning stages.

Table: Biodegradable Waste Management Facilities in the State

District Name	Total BDW Generation (TPD)	Total capacity of Compost plants (TPD)	Total capacity of Bio methanation plants (waste to energy plants) in TPD	Total Rendering Capacity (TPD)	Total BDW Processing Capacity (TPD)
Thiruvananthapuram	774.83	750.68	90.87	0.00	841.54
Kollam	567.14	347.93	67.28	15.00	430.21
Pathanamthitta	224.92	159.62	27.97	30.00	217.60
Alappuzha	424.15	410.21	62.08	0.00	472.29
Kottayam	393.31	325.35	31.12	27.00	383.47
Idukki	208.38	260.04	17.86	0.00	277.90
Ernakulam	779.34	571.42	72.48	242.00	885.90
Thrissur	691.90	530.48	92.47	6.50	629.45
Palakkad	601.79	424.06	99.66	93.25	616.97
Malappuram	968.70	534.50	126.00	278.50	938.99
Kozhikode	744.15	742.64	63.67	30.00	836.31
Wayanad	170.56	184.52	14.40	12.00	210.92

Kannur	564.81	477.63	57.91	54.00	589.54
Kasaragod	284.68	190.41	27.99	110.00	328.40
Grand Total	**7398.64**	**5909.49**	**851.74**	**898.25**	**7659.48**

For managing the 7398.64 TPD of biodegradable waste generated, there is a facility of 7659.48 TPD across the state and hence there are no existing gaps. In order to account for the future generation, the state is taking steps to strengthen the source level treatment system in rural areas and to establish centralized facilities in urban areas. With the available financial support from central and state, 2926.39 TPD capacity bio waste management facilities have already been installed at household, institutional and community levels in urban areas.

4.3.3. Non-Biodegradable Waste Management

For managing dry waste, women's self-help groups known as Harita Karma Sena collects primarily segregated dry waste from households and establishments, transferring it to Material Collection Facilities (MCFs) and Resource Recovery Facilities (RRFs) for further sorting and processing. At these facilities, after secondary segregation, recyclable waste is sent to recycling units, while non-recyclable waste is transported to co-processing facilities, such as cement plants, where it is used as Refuse-Derived Fuel (RDF) for energy recovery. Both government and private agencies ensure the safe transportation of waste.

4.3.4. Details of Solid Waste Management facilities in the state

FACILITY	TYPE OF PLANT	NUMBER	DETAILS
Centralized Plant	Windrow composting plants (large)	2	Kochi Corporation-100TPD Kozhikode Corporation-100TPD

	Windrow composting plants (Small)	25	1.Attingal -16TPD 2.Varkala - 4 TPD 3.Adoor - 2 TPD 4.Angamaly - 1 TPD 5.Koothattukulam – 0.5 TPD 6.Kothamangalam -2 TPD 7.Muvattupuzha - 2 TPD 8.North Paravur – 2 TPD 9.Perumbavur - 2 TPD 10.Chalakudy - 2 TPD 11.Irinjalakkuda - 4 TPD 12.Kodungallur - 4 TPD 13.Kunnamkulam - 8 TPD 14.Chittur Thathamangalam – 0.5 TPD 15.Palakkad - 10 TPD 16.Pattambi - 4 TPD 17.Shornur – 5.66 TPD 18.Perinthalmanna - 2 TPD 19.Kalpetta - 3 TPD 20.Kannur Corporation - 7 TPD 21.Anthoor – 2.50 TPD 22.Iritty - 1 TPD

			23.Koothuparamba - 5 TPD 24.Mattannur – 1.50 TPD 25.Thalassery - 2 TPD
Community Level	Vermi composting plants(Small)	10	1.Attingal – 0.25 TPD 2.Kattapana – 0.5 TPD 3.Mattanur - 5 TPD 4.North Paravur - 1 TPD 5.Chavakkad - 2 TPD 6.Chalakkudy – 0.5 TPD 7.Koothuparamba - 1 TPD 8.Perinthalmanna - 2 TPD 9.Manjeri – 0.5 TPD 10.Kuthuparamba - 1 TPD
	Material Collection Facility	1313	
	Resource recovery Facility	189	
Sanitary waste disposal Facility	Incinerator	3	Kochi – 3 TPD Thrissur – 5 TPD Palakkad – 1 TPD
Bio-remediation-Biogas plant	CommunityLevel	95	
	Institutional level	713	
	Household Level	34326	

Rendering plant	Rendering plant	39 Units	1.Kollam (185 TPD) 2.Pathanamthitta (30 TPD) 3.Ernakulam (7no.s, 242 TPD) 4.Thrissur(2no.s, 6.5 TPD) 5.Palakkad(6no.s, 93.25 TPD) 6.Malappuram (16no.s, 305.5 TPD) 7.Kozhikode(30TPD) 8.Wayand(12TPD) 9.Kannur (2no.s, 54TPD) 10.Kasaragod (2no.s, 110TPD)
Steel mills	Scrap recycling	18 Units	
Plastic recycling units	Plastic recycling units	187 Units	200 TPD
Road tarring	Used for road construction by PWD and LSGD		10TPD

Facility	**Up to March 2023**	**Up to Oct 2024**
RRF	93 Nos	167 Nos
MCF	1182 Nos	1272 Nos
Mini MCF	9357 Nos	19156 Nos
Godown facility	16 Nos	67 Nos
Godown Area	85,250 Sqft	481548 Sqft
Container storage facility		198 No.s

The state has made significant investments in infrastructure for the storage of dry waste. Currently, there are 167 Resource Recovery Facilities (RRF), 1272 Material Collection Facilities (MCF), 19156 Mini Material Collection Facilities (Mini MCF), and 67 storage

godowns covering an area of 4,81,548 square feet. Additionally, 198 used shipping containers have been repurposed for waste storage, facilitating easier transportation of waste.

4.3.5. Non Biodegradable Waste Management Facilities in the State

District Name	Total BDW Generation (TPD)	Facilities in Local Bodies (TPD)	CKCL Godown Facility	Pvt agency Godown facility (TPD)	Total NBDW Processing Capacity (TPD)
01 Thiruvananthapuram	239.67	127.68	87.36	23.20	238.24
02 Kollam	166.30	124.43	92.94	6.25	223.61
03 Pathanamthitta	63.41	61.87	29.74	28.98	120.59
04 Alappuzha	121.05	137.13	44.61	4.00	185.74
05 Kottayam	111.78	108.09	74.35	2.00	184.44
06 Idukki	57.58	58.77	89.22	0.46	148.44
07 Ernakulam	239.46	151.45	78.07	10.50	240.02
08 Thrissur	203.75	212.45	44.61	3.00	260.06
09 Palakkad	169.08	132.62	31.23	9.00	172.85
10 Malappuram	278.08	166.42	102.60	14.60	283.63
11 Kozhikode	226.63	127.07	29.74	49.96	206.77
12 Wayanad	48.43	29.10	37.17	5.00	71.28

13 Kannur	168.45	164.94	118.96	2.45	286.35
14 Kasaragod	80.06	84.46	74.35	1.00	159.81
Grand Total	**2173.72**	**1686.48**	**934.94**	**160.40**	**2781.83**
Kerala Enviro Infrastructure Ltd (KEIL)					**16.00**
Grand Total (TPD)					**2797.83**

All local bodies have developed comprehensive plans for the movement of vehicles to collect waste from households and transport it to processing facilities. The implementation of these plans is monitored at both the district and state levels through the Harithamithram App, ensuring efficient waste collection without accumulation and adequate availability of vehicles for waste management. To enhance oversight, all waste-transporting vehicles are required to have GPS tracking, and the Kerala State Pollution Control Board has set up a web portal for real-time monitoring of waste-carrying vehicles, both within and across state borders.

Efforts are also underway to equip Material Collection Facilities (MCFs) and Resource Recovery Facilities (RRFs) with the necessary tools for effective waste management, such as conveyor belts and baling machines. To enable easier transportation and reduce the reliance on landfills, the generated reject waste can be converted into Refuse Derived Fuel (RDF). In line with this, four RDF plants have been established in the Thiruvananthapuram and Cochin Corporations. Additionally, the government is working with local bodies to implement interventions for setting up cluster-level facilities across the state. RDF plants help divert non-recyclable waste from landfills, which reduces the volume of waste that needs to be disposed of, extending the lifespan of landfills and reducing the associated environmental hazards.

Additionally, Information, Education, and Communication (IEC) initiatives have been intensified to discourage open littering. Local Self-Government Institutions (LSGIs), as well as public and private sector entities, are being ranked based on their performance in waste management and cleanliness. To enforce regulations and prevent illegal dumping, 23 enforcement squads were established in March 2023 to carry out inspections and ensure compliance. Furthermore, control rooms are being set up at the district and local self-government levels to closely monitor waste collection and ensure its proper disposal.

4.3.6. Legacy Waste Management

Legacy dump sites are remediated through biomining, a process that utilizes microorganisms and natural methods to excavate, treat, segregate, and recover valuable materials from long-accumulated waste dumps. These legacy wastes consist of organic matter, plastics, metals, and other materials that have been compacted and decomposed over many years. The soil produced from biomining is utilized to fill low-lying areas at various locations. This process effectively sorts the waste into various categories, including soil, stones, RDF, glass, plastic, tires, wood, and footwear.

A total of 59 dump sites have been identified across the state, consisting of the previously reported 44 sites and 15 newly identified sites. Bioremediation has been completed at 24 sites, while work is currently ongoing at 10 sites. The remediation process is set to commence at 25 additional sites. The quantities of processed waste are detailed in the table below.

	Number of Sites	**Processed quantity (MT)**	**Unprocessed quantity (MT)**
Total Reported sites	44 Nos.		**17,61,871.98 T**
Completed Sites	19	345793.15 T	
Work in Progress	10	461367.00 T	644157.16 T
Not yet started	15		310554.19 T
Total		**807160.15**	**954711.35 T**

Newly identified sites after 2018	15 Nos.	129486.19 T	
Completed Sites	5	12,485.4 T	
Not yet started	10		117001.19 T

4.3.7. Plastic Waste Management Plan

The State is taking steps for the implementation of Plastic Waste Management rules in the State. Plastic Waste generation is around 71,000 tonnes in 2023-24 in the State (Annual Report 2023-24). This includes both soft and hard plastic. Hard plastic and some quantities of soft plastic are recyclable and are taken by scrap merchants through their field workers. Currently, 35352 Haritha Karma Sena is working in 93 urban local bodies and 941 Gram Panchayats for collection of dry waste. For wet wastes disposal decentralized treatment methods such as aero bins, pipe compost, compost pits, kitchen bins, biogas plants etc. are followed. Dry wastes are collected, segregated and disposed through recyclers. In Kerala there are 123 registered plastic recycling units. Non-recyclable plastic waste is shredded in the RRFs and is used for the tarring of PWD and LSGD roads. The Clean Kerala Company Limited (CKCL) has produced 3617 MT of shredded plastics and given to various agencies (NHAI - 13.93 MT, PWD - 1635.25 MT, LSGI - 1710.64 MT). 17699 MCFs and 136 Resource Recovery Facilities have been provided in LSGIs. Bailing machine and shredding machines are provided in the Resource recovery facilities and 123 numbers of registered plastic recycling units in Kerala. Majority of units are in Perumbavoor.

4.3.8. Construction and Demolition(C&D) Waste

C & D Waste Management Rule, 2016 apply to every waste resulting from construction, re-modeling, repair and demolition of any civil structure of individual or organization or authority generating construction and demolition waste such as building materials, debris, rubble. C&D waste processing activity falls under orange category(as per CPCB guidelines), processing of construction waste is aimed at segregation/conversion of the construction & demolition waste for reuse, recycling and/or transformation into new products.The quantum of construction waste generated as per CPCB Guidelines dated are as follows:

a. Range 40-60 kg per sq.m of new construction,

b. Range 40-50 kg per sq.m of building repair,

c. Range 300-500 kg per sq.m for demolition of buildings.

Construction & demolition waste is approximately 10% of the municipal solid waste. Demolition of buildings can be done either by manual methods (using excavators, bulldozers, sledge hammers, jack hammer, drillers etc) or by engineering methods (wrecking ball, pusher arm, concrete saw, implosion etc).

The following facilities shall be provided in the construction/demolition sites:

1. Construction & demolition waste need to be segregated into concrete, soil, steel, wood, plastic, brick & mortar, paper (eg:paper sack cement bags), glass, ceramic, electrical items and metallic items.

2. Separate storage areas need to be earmarked in the construction site for segregation & storage of each type of construction/demolition waste.

3. Construction waste shall not mix with domestic waste.

4. Enclosure of the construction site using garden nets/GI sheets shall be done to prevent spreading of dust to the nearby areas.

5. Water storage facilities with adequate number of waste sprinklers shall be provided for containing the dust generated.

6. Only DG sets having acoustic enclosure shall be used in the site.

7. Facilities for treatment of sewage generated from the workers quarters shall be provided. Domestic solid waste generated from the workers quarters shall be segregated and bio-degradable solid waste shall be treated using bio-gas plant, compost etc.

The application for the consent of the Board shall be accompanied by the following details:

a. Average quantity (in tons per day) and composition of construction and demolition waste to be handled at the specific site.

b. Details of construction and demolition waste processing or recycling technology to be used.

c. Quantity of construction and demolition waste to be processed per day. Site clearance from Prescribed Authority.

d. Salient points of agreement between competent authority or local authority and operating agency (attach relevant document).

e. Expected amount of process rejects and plan for its disposal (e.g., sanitary landfill for solid waste).

f. Measures to be taken for prevention and control of environmental pollution. Investment on project and expected returns.

g. Measures to be taken for safety of workers working in the processing or recycling plant.

h. Any preventive plan for accidents during the collection, transportation and treatment including processing and recycling should be informed to the Competent Authority(Local Authority) or Prescribed Authority.

4.3.9. Construction and Demolition Waste Management Plan

Status of C&D waste management in Kerala

District	Number of municipal authorities responsible for Management of Municipal solid wastes in the State / UnionTerritory under these rules	Municipality	Total quantity of waste generated (ton per year)	(Area for collection of C & D Waste)Status
Thiruvananthapuram	6	Thiruvananthapuram Corporation	4501.46T	
		Nedumangadu Municipality	1460 T	C & D Shed is proposed at Parangottela.

Kollam	4	Kollam Corporation	3650 T	Project taken up in the financial year 2024 – 2025 for a new C & D facility
		Panmana Panchayat	1.05 T	.
Alappuzha	6	Kayamkulam Municipality	2	21.79 m^2 land for C & D Waste collection near Iron bridge & Anatharaveli
		Pulinkunnam Panchayat	27.21 T	
		Alappuzha Municipality	183 T	
		Kulanada Panchayat	5 T	
Pathanamthitta	4	Thumpamon Panchayat	15 T	
		Kottangal Panchayt	8 T	
		Thottapuzhassery Panchayat	100 T	
Kottayam	66	Njeeshoor Panchayat	3T	
Idukki	2	Kattappana Municipality	569.4 T	
		Vandiperiyar Panchayat	42 T	
		Thodupuzha Municipality	321.2 T	
		Kanthalloor Panchayat	5.7 T	
		Kanjikuzhi Panchayat	3 T	
		Vathikudy Panchayat	183 T	
Ernakulam	13	Sreemoolanagaram Panchayat	9000T	
		Aluva Municipality	521 T	A land has been identified at ward 26 of ULB feasibility study need to be done at Perumbavoor.
		Thrikkakara Municipality	1095 T	
		Kalamasseri Municipality	277 T	C&D Waste storage shed of 1000 sqft and 10 cents of land allowed in SWM plan at Aluva
		Kochi Municipality	500 T	
Thrissur	6	Chavakkad Municipality	270.27 T	
		Kunnamkulam Municipality	870.9 T	C & D Waste Processing plant at Kunnamkulam (Operational)

		Engandiyoor Panchayat	1 T	
Palakkad	7			
Malappuram	12	Perinthalmanna Municipality	900 T	
		Kondotty Municipality	800 T	
		Parappanangadi Municipality	780 T	
		Nilambur Municipality	504 T	New land for MCF is hired and separate area will be allotted for C & D waste
		Kottakkal Municipality	145 T	
		Tirur Municipality	275 T	
		Manjeri Municipality	3 T	
Kozhikode	7	Omassery Panchayat	50 T	50 m^2 land for C & D waste collection.
		Ramananattukara Municipality	464 T	Ward 7, Ramanattukara (Collection point)
		Payyoli Angadi Panchayat	87.165 T	
Wayanad	3	Kalpatta Municipality	457.34 T	Land identified and Geotagged for C & D waste storage facility
		Mullankolly Panchayat	35 T	
Kannur	9	Anthoor Municipality		Collection and storage point at Anthoor(5 cent land)
		Payyannoor Municipality	895 T	1 ace revenue land identified for C & D waste management at Payyannur.
		Panoor Municipality	218.54T	
		Kallasseri Panchayat	1 TPA	
		Kannur Municipality	132 T	

		Sreekandapuram Corporation	91.25 T	20 cent land at Kavumbai, 30 cent land in Palapparamba, proposed collection point in mattannoor Municipality, 30 Lakh C & D proposed Waste processing project
		Kanjangadu municipality	1419.85T	
		Koothuparambu Municipality	475 T	
		Mattannoor Municipality	76.65T	
Kasaragod	3	Neeleshwaram Municipality	365 T	314 m^2 land for C & D Waste collection at Parappuram, Kuzhur Panchayath KSWMP project for C & D Waste Management collection facility at Nileshwaram

Consent to Establish has been granted to M/s Seaqueen Environmental Solutions Pvt. Ltd. for setting up a C&D waste processing facility at Kadungalloor Grama Panchayat, Ernakulam district, with a processing capacity of 10 TPH using 381 HP machinery. Similarly, Consent to Establish has been issued to Arangathu Aggregates, Ayarkunnam, in Ayarkunnam Grama Panchayat, Kottayam, for setting up a C&D waste disposal facility.

As per the draft of C & D Waste Management rules, 2024, extended producer responsibility obligation shall apply to all producers. (This shall come into force with effect from 01/04/2025).

4.4. Management of crop residues post harvest in Kerala

Burning of crop residues /stubble burning on a large scale is not practised in Kerala. The hay is used as cattle feed and the stubble is usually ploughed back to the soil before the start of the next crop. In fields, the crop residues are used as cattle feed or for insitu composting in fields or incorporated to soil for the next crop. The crop residue is also used for making composts or

organic manure, Used for biogas generation as domestic fuel, used as soil mulching material. Hay is used for mushroom cultivation, hay is used as thatching material. In general, burning of crop residues is not posing an issue to the air quality in Kerala.

4.5. Baseline Assessment - Source Identification (Source Apportionment/ Emissions Inventory and Key Pollutants)

As per the Hon'ble NGT Order dated 14.07.2021 in OA 76/2017, 259/2017 & 260/2017, it was directed to conduct Source Apportionment Studies in Kochi & Thiruvananthapuram cities in Kerala. The Environment Department, Govt. of Kerala was directed to conduct the study and the Committee appointed by the Hon'ble Tribunal to provide necessary guidance for the study. As per the direction from Government of Kerala, proposals are invited from institutions approved by the project steering committee of CPCB. Actions are being taken for entrusting an agency for conducting Source Apportionment Study.

4.6. Carbon Neutral Kerala Initiative

The State government has declared its ambitious carbon neutral target to be achieved by 2050 and is keen to formulate an action plan for carbon neutrality. To facilitate this, the State has constituted a Working Group as per G.O. (Rt) No. 81/2021/Envt dated 10.11.2021, with the Additional Chief Secretary, Environment, as the Chairperson, to draw up an action plan for achieving carbon neutrality by 2050. The State Action Plan on Climate Change (SAPCC) 2.0 (Approved in principle by the State Govt as per G.O. (Rt)No 4/2023/Envt dated 21.01.2023) devised strategies and interventions for climate change adaptation and mitigation for the 2023-30 period. The planned mitigation strategies devised in SAPCC 2.0 for the 2023–30 period could avoid ~ 57000 kt CO2 in 2030 from various sectors.Further, the Climate Change Cell (CCC) of the Directorate of Environment and Climate Change (DoECC) is leading the initiatives for the formulation of the Carbon Neutral Framework for the State in coordination with all the major stakeholder departments/agencies. In this regard, the DoECC has partnered with Vasudha Foundation, an independent not- for-profit policy research institution, working in the areas of climate policy and clean energy, for a detailed Greenhouse Gas (GHG) inventory for the State of

Kerala and the development of a Carbon Neutral Pathway. DoECC has conducted the GHG inventory for the period 2005 to 2021, accounting for carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) emissions. This inventory has covered all four sectors: Energy, IPPU (Industrial Processes and Product Use), AFOLU (Agriculture, Forestry & Other Land Use) & Waste, and all relevant sub-sectors in the State that contribute to GHG emissions, as given in the methodology guidelines developed by the Intergovernmental Panel on Climate Change and prepared a comprehensive report. As per the assessment, the gross GHG emission of the State in the year 2021 was 21.86 million tonnes of carbon dioxide equivalent (MtCO2 e) and Net emissions from the State, after accounting for the removals through sequestration, stood at 11.60 million tonnes of carbon dioxide equivalent (MtCO2 e). The Energy sector (~78% of the State's Gross emissions) is identified as the lead emitting sector in the State followed by the Waste sector, the Agriculture sector, and the Industrial Process and Product Use sector. The Transport sub-sector primes the Energy Sector emissions, constituting ~62% of the total Energy sector emissions and ~49% of the gross emissions of the State. These outcomes have implications for specific policies and near- term strategies in climate change intervention in the State. A web portal has also been developed to host all these datasets. Building on this inventory, the DoECC has prepared draft Carbon Neutral Pathway for the State, aiming to achieve carbon neutrality by 2050. Currently, DoECC is in the process of finalization of this draft pathway.

5. CHALLENGES IN AIR QUALITY

Action Plan for Air Quality in Kerala, developed in compliance with the directives of the National Green Tribunal in OA 159/2021, underscores the state's commitment to improving and sustaining air quality for the well-being of its citizens and the environment. This comprehensive plan aligns with national and international standards while addressing region-specific challenges. By implementing targeted measures such as emission reduction strategies, effective waste management practices, the promotion of green infrastructure, and robust monitoring systems, Kerala aims to achieve significant improvements in ambient air quality. Public awareness campaigns and stakeholder participation are integrated into the plan to ensure widespread understanding and community involvement in achieving cleaner air.

The major challenges faced are :

1. Lack of coordination among the stakeholders
2. Lack of fund for carrying out the activities in the action plan
3. Lack of manpower for the implementing and monitoring of these action

5.1. Industrial Emissions

Industrial activities are an important part of Kerala's economy, but they also contribute to air pollution, particularly in urban and industrial zones. While Kerala's Pollution Control Board has made efforts to regulate emissions and ensure compliance with environmental standards, challenges remain in terms of enforcing these regulations uniformly across all industries.

Challenges:

- Some industries may face challenges in upgrading pollution control technologies due to cost constraints.
- Enhanced collaboration between industries and regulatory bodies could help improve emission control practices and ensure better environmental outcomes.
- The ambient air quality monitoring reveals that increase in particulate matter noticed in areas like Perumbavoor, Thrissur, Eloor, Kollam, Kanjikode. In Perumbavoor, Kanjikode areas emission from industrial units namely plywood, steel mills , and from units in Eloor-Edayar area are to be controlled by monitoring the emission through stacks.

5.2. Vehicular Emissions

Vehicular emissions are another major source of air pollution in Kerala, especially in urban areas like Thiruvananthapuram, Kochi, and Kozhikode. With a growing population and increasing urbanization, the number of vehicles on the road has risen dramatically. Govt. of Kerala has implemented measures such as promoting the adoption of Bharat Stage VI (BS-VI) emission standards and encouraging the use of cleaner fuels. However, increasing vehicular population and the challenges of upgrading old vehicles pose ongoing difficulties in controlling emissions.

Challenges:

- The major source is the emission from vehicles considering the more number of vehicles roads are to be widened, mass transportation is to be encouraged, emission especially from high duty vehicles is to be controlled.
- Restriction in the land acquisition for development of road infrastructure.
- Implementation of advanced construction technologies due to varying road geometrics.
- The Transport and Motor Vehicle Department has implemented stringent measures to regulate emissions from vehicles, monitor air quality, and enforce standards.
- The state has introduced initiatives like the promotion of electric vehicles (EVs) to reduce emissions, but the shift towards cleaner vehicles requires time and investment.
- The State Govt. continues to advocate for a stronger public transportation network to reduce dependence on private vehicles, but the need for more sustainable and efficient transport systems remain.

5.3. Construction and Demolition Waste

Rapid urban development in Kerala, especially in cities, has resulted in large amounts of construction and demolition (C&D) waste. If not managed properly, this waste can contribute to dust and particulate pollution.

Challenges:

- C & D waste Processing and collection facilities are to be provided.
- Difficulty in identification of land for the management and disposal of Construction and Demolition waste.
- Lack of expertise in the field of Construction and Demolition waste management.

5.4. Road Dust

Road dust, often overlooked as a significant source of air pollution, contributes to particulate matter (PM10 and PM2.5) levels in urban areas. Poorly maintained roads, the presence of debris,

and traffic congestion exacerbate this issue. The sheer volume of traffic and the condition of some roads in Kerala make it difficult to manage road dust effectively.

Challenges:

- Road dust from poorly maintained rural roads continues to contribute to local pollution levels, which is compounded by limited resources for maintenance.
- Lack of properly maintained roads in rural and urban areas and lack of green cover and vegetation along roadsides contributes to the issue.
- Construction activities of National Highways & other State Highways and other road and building constructions. Action plan for controlling dust and its implementation is to be ensured by the stakeholders.

5.5. Solid Waste Management Issues

Kerala has made significant strides in waste management, with an emphasis on source segregation, composting, and waste-to-energy projects. However, improper waste disposal, including open dumping and burning of solid waste, continues to affect air quality. The State took significant effort in setting guidelines for waste management and monitoring the implementation of these practices. Despite these efforts, challenges such as improper segregation, lack of proper infrastructure, and waste burning in certain areas persist. The State is actively involved in promoting public awareness on the importance of waste segregation and the harmful effects of burning waste. Local bodies are encouraged to develop integrated waste management solutions, and the State provides technical and financial support for waste-to-energy projects.

Challenges:

- Drastic improvement in solid waste management has been observed, however facilities are to be provided for the complete prevention of burning of dry leaves waste, etc.
- Despite these efforts, challenges such as inadequate waste processing infrastructure and a lack of community participation in waste segregation continue to affect the overall success of waste management programs.

5.6. Solid Waste Burning Due to Lack of Public Awareness

The State Govt. has been working tirelessly to educate the public about the dangers of waste burning and promote alternatives like composting and proper waste disposal methods.

5.7. Lack of Manpower and Resources for Air Quality Management

The demand for more air quality monitoring stations, better data collection, and enforcement of regulations requires a robust infrastructure, which remains limited in some areas.

Challenges:

- The KSPCB is continually working on strengthening its capacity by increasing the number of air quality monitoring stations across the state and upgrading data analytics systems.
- Limited manpower and resources at the local level hinder the effective implementation of air quality management strategies.

5.8. Public Awareness and Policy Gaps

Public awareness about air pollution and its impacts on health is crucial in addressing the issue effectively. There is still a need for more robust public engagement and policy implementation at the grassroots level.

Challenges:

- Although there are several initiatives, achieving widespread public participation and behavioral change remains a challenge.

6. CONCLUSION

Action plan on Air quality has been prepared with the involvement of different stakeholders. The action plan including the focus areas, tasks, responsible agencies, financial implications and time lines are attached as **Annexure**. The success of this plan hinges on the coordinated efforts of government bodies, industries, and the public. Continuous evaluation, timely course corrections, and the incorporation of emerging technologies will ensure the action plan remains adaptive to evolving needs. Kerala's air quality action plan serves as a proactive framework to mitigate air pollution and promote sustainable development. Its successful execution will contribute to creating a healthier, more livable environment and reinforce the state's role as a leader in environmental stewardship.