

3.3.3. Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during last five years

3.3.3.1. Total number of books and chapters in edited volumes/books published and papers in national/ international conference proceedings year-wise during last five years

2020-21	2019-20	2018-19	2017-18	2016-17
329	107	54	44	35

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Abstract: Micronutrient malnutrition is a serious issue in rural-dominated developing nations, such as those in Asia and Africa, and millions are impacted. People are more vulnerab... [View more](#)

► Metadata**Abstract:**

Micronutrient malnutrition is a serious issue in rural-dominated developing nations, such as those in Asia and Africa, and millions are impacted. People are more vulnerable to concealed hunger and malnutrition as a result of their consumption of carbohydrate-rich foods that are low in micronutrients. Iron is regarded as the most important ingredient of a plant, which contains a variety of enzymes and pigments. These help plants in the generation of energy as well as the reduction of nitrate and sulphate. Multiple mobile Robots with wireless sensor networks utilizing Ad-hoc topology are deployed in this article to carry out field operations. The communication of multiple mobile robots with technologies enables to launch complex missions. Such an arrangement would allow the target achievement with greater accuracy and efficiency. Further, the idea of fuzzy logic is also proposed to achieve the desired goal of farming in terms of procedure and reap. From simulation result, it is shown that the fuzziness have provided additional edge towards the robotic movement.

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 **Contents**

I. Introduction

Agricultural-business sector is facing a drastic and inclined change due to the growing demands and multidimensional technological advancements. The technological scenarios are promising to empower the essentials such as degree of homesteads and gainfulness efficiently. In an economy of a nation Agriculture is considered as the major sector, which also is the back bone for the raw material supply for agro-unified sectors. Majority of cultivation is of sugar cane (), Rice (), Wheat (), Pulses (1.5 mg). Knowing the constituents of the soil is considered as the important aspect. Several techniques based on sensors or electrodes and optical methods are available for measure the supplements present in the soil. With the 2 stages of agricultural

revolution such as “Automation” and “Green revolution” [1], the Agro-Field sector has gained a rapid recognition throughout. Iron is considered as one of the crucial aspect necessary for plant growth and reproduction. Iron is a micronutrient and required by plants in limited quantities. Fuzzy logic has become a significant approach for various applications going from the control of

designing frameworks to Artificial Intelligence. With mobile robots under consideration the protocol for communication is vital in order to provide satisfactory performance, especially in real time environment. Agribusiness is seeing fast reception of Artificial Intelligence (AI) both as far as rural and infield cultivating strategies. Abstractive preparing has been good to go to turn into the most advantageous innovation in horticulture proficiency as it can appreciate, learn, and react to different conditions to build proficiency. The remote network gives the advantage to fabricate a different multi-robot organization and association between each robot in the field and passage. As Mobile robots work under a network which is organized and decentralized, there will be no requirement on reliance of fixed networks. Mobile Robots travel around the area scout with prior goal will revert the data acquired around the travelled path. The robots which move freely over a passage are considered as Portable Hub and can be utilized or framed in any aspect [2]. A decentralized method of remote organization doesn't depend on a previous foundation, for example, switches in wired organizations or passageways. Virtual wireless Ad-hoc network performs unconstrained usage of a remote organization of mobile network to the space of portability. The assurance of which Robots forward the data is made powerfully based on network availability and the Positioning system of the every portable robot on the section. Ad hoc network additionally fill in as a correspondence mode that permits interior

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versatile framework to straight forwardly communicate with neighbor Robot without a particular connection. Remote impromptu organizations are self-designing, powerful organizations in which hubs are allowed to move. For robotic control a hybrid technique combining fuzzy-logic is utilized [3]. The high-precision global positioning system helps to locate the

exact position of MRS on the field with task provided to achieve. Every Fuzzy-Robot system has wireless LAN support, navigation support and an Access point. A Fuzzy Inference Multi-Mobile Robot System (FIMRS) is used to interpret the evaluation of the soil tests carried out on the ranchers area scout. Ad-Hoc network and Multi-Robot systems follow a communication protocol in which it reduces the energy and time consumption of the each node in approaching towards achieving goal. Though some Robots in network fails to have a connectivity with central object, sensor oriented Fuzzy logic system helps us to achieve the sustainability of the end goal.

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In the Present era, with changing lifestyles of families, infant care is one of the most challenging tasks faced by parents. The parents either have to work or have household chores to take care of so it's not easily possible to keep an eye on their babies. A baby monitor becomes very helpful in these scenarios to make sure of their child's safety. The device will help to detect the sound produced by the baby and keep the parents well informed about the baby's condition. However, some monitors do not satisfy safety requirements, especially when it comes to hearing impaired parents. Therefore, this research paper aims to fulfill the above requirement by developing a baby monitoring system to help the hearing-impaired parents to attend to their child(ren). The device will consist of an Arduino Uno, few sensors and a small hardware device which will display the infant's condition. This hardware device is capable of measuring the temperature, moisture content as well as the child's voice. This device will vibrate and messages will be displayed on the LCD. This proposed prototype is convenient for hearing impaired parents to aid their child.

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The world is moving at a very fast pace in this generation. There is an enormous increase in the graph of working women in the society. In case of families with children, the father as well as the mother work and contribute to their family and make ends meet as well as contribute to the society. Nevertheless, taking care and aiding for their children is one of the top priorities for parents and their well-being and whereabouts are always a concern for the parents. In the current scenario, where parents work to provide for their family as well as for themselves, handing over their child to a babysitter or nanny becomes increasingly risky as well as adds up as an extra tension to their lives, considering the fact that many of them indeed indulge in child trafficking. In these

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cases, a baby monitoring system could be very effective and the parents can develop a peace of mind knowing their child's well-being.

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For any organisation or enterprise the entry of visitors is inevitable. It is of prime importance that how efficiently and effectively the visitors are managed in terms service to them. To provide satisfactory response to the visitors the host or reception must be smart and alert so as to cater the various requirements. Such personnel in the organisation would be working rigorously entire time in attending or responding to the visitors. It is the matter of fact that any unintentional human error or negligence can have negative impact on working structure of the host. In this paper a low cost micro controller based system has been developed for automatizing the students visiting to their department head for various purposes. Implementation results are also presented for typical activities involved in an Engineering Institution those are of routine in nature.

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Most of our daily or routine activities in our life are largely based on querying, in particular the office based or authority based requirements. All the private or government sector offices, hospitals and all business firms, educational institutions and travel or transport fall in this category that involves queries. The most common practise of addressing this concern by all hosts is through a reception desk at the entrance. Before the visitants are serviced by the reception they have to go through the formal security check procedures at the gate level itself. Such a formal approach of visitors management not only time consuming but also considerable man power is involved. In the current era of digitization and bearing in mind about the future technological developments manual based visitor management may cause a lot of administrative and organisational hurdles [1]. As mentioned above other than time consuming and man power few specific demerits includes

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Number of visitants serviced would be reduced,

-

No smart database could be possible for any future concerns,

-

Not eco friendly as lot of stationary is involved,

-

Visitants would be deprived from proper acknowledgement or status of their query,

-

Host will not have any information about stay duration of visitors for security and confidentiality reasons

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Abstract:

Cardiac arrhythmia is an abnormal heartbeat or rhythm. The heartbeat rate becomes too fast or when the heartbeat rate is irregular, the ability of the heart to pump blood will be affected. This will eventually reduce the blood flow through the brain which may result in loss of consciousness, dizziness, or even death if the required procedures are not carried out in time. The main aim of the proposed work is to alert some person or people nearby when a patient has an irregular heartbeat. The proposed work implemented Electrocardiogram integrated with micro-controller that monitor the heartbeat of a person and detects the type of arrhythmia, bradycardia or tachycardia based on the heart rate. The threshold set for bradycardia is 60bpm and for tachycardia is 100bpm. The system detects for the irregularity in heartbeat, which could later lead to an unanticipated event. Since the patient experiencing the attack is powerless during his/her sleep, an alarm is provided which is triggered and SMS is sent to registered mobile number with temperature, pulse rate and SpO2 values with type of arrhythmia in case of abnormality. This would alert people around the

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patient and then necessary immediate would be taken. The vital values are displayed on LCD.

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Arrhythmia is an irregularity in the heartbeat. It causes poor blood circulation through the body from the heart. Most of the Arrhythmias that occur are temporary and not much harmful.

These types of Arrhythmia are those in which there occurs skips in heart beat or number of heart beat per time duration increases.

Often a cross-over or an extra hitting is the result of strong emotion or exercise. Few arrhythmias lead to medical

emergencies which cause sudden cardiac arrest or sudden death

[13]. Sudden arrhythmias like sudden arrhythmia death syndrome

[10]. Sudden arrhythmias like sudden arrhythmia death syndrome are the most deadly type as it occurs when people are asleep, since they are helpless at that point. Other arrhythmias can be annoying since they cause Symptoms like awareness of a heartbeat or palpitations. The palpitations are known to be caused by the atria, wire malfunctions, or other problems with pacemakers.

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Remote Sensing has received paramount attention in the recent past due to its numerous applications in environmental studies to benefit the living beings. The advancements in imaging techniques have taken place leveraging the sophisticated tools proposed in remote sensing methods. Synthetic Aperture Radar (SAR) has been a key player in improving the spatial resolution of the imaging radiometry. In this paper, a review on the SAR technique highlighting its characteristic features, different types, existing problems and proposed solutions and future opportunities is presented. The main motivation for this work is to present the existing challenges and opportunities for the technicians in the SAR field so that the currently existing SAR datasets can be utilized to improve the SAR technologies.

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Earth remote sensing mainly deals with acquiring of wealth of key data about the earth systems, helps in the decision making based on the present and future state of the earth. Earth remote sensing has been proven to be instrumental in crop monitoring, biomass assessment, urban planning, water resource management, geology and many more. Fig. 1 represents the fundamental framework of remote sensing operation. It represents the reflection of many kinds of objects on the earth's surface and the received information is transmitted as a signal to the ground station.

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Trend Analysis of Sulphur Dioxide in Bangalore & Effectiveness of Control Measures

Soundarya N

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Abstract. Bangalore is a city in the Indian state of Karnataka. Many public sector businesses and R&D organisations, such as Hindustan Aeronautics Limited, Indian Space Research Organisation, Airbus, Boeing, General Electric (GE), Nokia, Toyota, and others, are housed here. Bangalore is known as India's 'Silicon Valley', as it is home to many information technology (IT) enterprises. It is classified as a 'non-attainment city', meaning that pollution levels do not match the Central Pollution Control Board's (CPCB) criteria. A high-level computer language called PYTHON was used to draw the trends of the air quality data collected over a 15-year period (2004-2019). PYTHON was used to clean, group, sort and aggregate the collected data to obtain the exceedance factor and draw the trend graphs. The policies of the Central Pollution Control Board (CPCB) and the Karnataka State Pollution Control Board (KSPCB) were examined to better understand the pattern. Over the years, the CPCB and the KSPCB have established a number of policies and guidelines, and the success or failure of these policies was examined in order to gain a better knowledge of the control measures. This report lays the groundwork for future policy implementation in other cities.

1. Introduction

At an elevation of 920 metres above sea level, Bangalore is located in the heart of the Precambrian Deccan Plateau (MSL). The coordinates are 12.54°N 77.22°E, and the area is 741 km² [1]. India is one of the world's developing countries, and it is facing a major air pollution challenge, which is a negative consequence of the growth process [2]. According to this report deaths linked with air pollution are due to the effects on lungs, damage to brain, throat issues and various forms of cancers. This shows a clear sign of the decreasing life- expectancy. A total of 2 billion individuals in India are exposed to excessive levels of air pollution [3]. During the year 2004 Bangalore saw a major change in the number of manufacturing industries. The industries include Engineering, wood, textiles, chemicals, plastics and metals. The air- quality became a cause of concern as there were no proper system in place to monitor pollution at the source. Hence, the CPCB and KSPCB started making action plans to step by step curb the pollution. Which will increase the air- quality. Only during the year 2014 National Air Quality Index was launched which included 8 pollutants. SO₂ is one among them. There is an increased need to understand the trends of SO₂ pollution in Bangalore. Understanding of the trends help the policy makers to identify the trouble areas and make policies to reduce the pollution levels. For the last two decades Karnataka government and the central government has tried to implement various pollution control methods to curb the rapidly increasing pollution levels in Bangalore. This paper tries to consolidate all the pollution control methods implemented from the year 2004- 2019. It discusses the success and failure of the measures implemented in Bangalore. The



understanding can be used to implement the same measures in other highly polluted cities in India like Delhi, Mumbai etc.

2. Study Region

Karnataka state's capital is Bangalore city. It houses major industrial areas and IT hubs [4]. The study area has been divided into three zones namely industrial, residential and sensitive areas. Air quality monitors are located in Victoria Hospital & Bangalore University (Sensitive areas), KHB, Graphite India & Peenya (Industrial areas) and Yeshwanthpur & AMCO Batteries (Residential Areas). These areas are represented in figure 1 taken from the map of Karnataka [5].

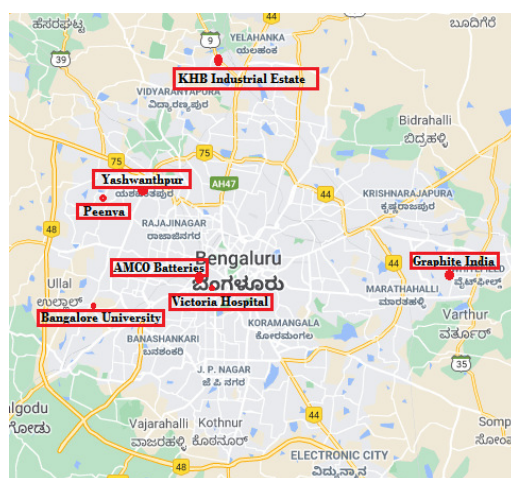


Figure 1 Bengaluru Region Map.

3. Methodology

Data was collected, grouped and aggregated using PYTHON and trends and impacts of the control measures were analysed individually for every region.

3.1. Data Collection

Data from 2004- 2019 was collected from CPCB and Ministry of Environment, forests and climate change (MOEF & CC) with an accuracy of 98%. Field equipment adhering to NAMP guidelines were used for this purpose. The data was cleaned & sorted before using the PYTHON programming language.

3.2. Trend Analysis Using PYTHON

Python was made by Guido van Rossum in the year 1991. PYTHON serves as a high level general purpose programming language [6]. Application of this language is seen in most fields like Scientific & Numeric computing, software development, business applications, education and web development. In the recent years its potential has been tapped by civil engineers in urban planning for population forecasting, predicting traffic trends etc. This software was used in this study to sort, group and aggregate data to get simplified graphs for the analysis.

3.3. Data Analysis

Pollution data collected is presented as concentration levels in $\mu\text{g}/\text{m}^3$. For every pollutant CPCB has established annual standards [7]. Every pollutant's Exceedance Factor can be determined using the following formula [8], and the criteria for comprehension have been tabulated in table 1.

$$\text{Exceedance Factor (E.F)} = \frac{\text{Observed Annual Mean Concentration of a Criterion Pollutant}}{\text{Annual Standard for the Respective Pollutant}} \quad (1)$$

Using Eqn 1 the factors for the pollutants were found and the results are tabulated in table numbers 2, 3 & 4. The criteria for EF [8] has been shown in table 1.

Table 1 Air Quality Levels.

EF Range	Abbreviation used	Air Quality Levels
<0.5	L	Low Pollution
0.5 – 1.0	M	Moderate Pollution
1.0 – 1.5	H	High Pollution
>1.5	C	Critical Pollution

4. SO₂ Levels

Sulphur dioxide (SO₂) is a poisonous gas that is colourless and has a pungent odour. It is produced when fossil fuels such as coal, petroleum, diesel, and other oils are burned. Sulphur dioxide is released even when other compounds containing sulphur are burned. Power stations, metal processing and smelting factories, and automobiles that run on fossil fuels are among the sources [9]. Sulphur dioxide emissions from diesel cars and equipment have long been a big problem.

4.1. Health Impact

In general air pollution is the cause of many premature deaths as it affects human health in various ways [10]. Sulphur dioxide can aggravate respiratory sickness by making breathing more difficult, particularly in youngsters, the elderly, and people with pre-existing disorders. When exposed to it, it also irritates the eyes. Longer exposures can aggravate a variety of lung problems, including coughing, asthma, chronic bronchitis, and respiratory tract infections, as well as cause cardiovascular effects [11].

4.2. Industrial Regions

Levels of SO₂ in industrial regions Table 2 and figure 2 demonstrate the performance of Graphite India, KHB, and Peenya from 2004 to 2019. Graphite India's levels have been considerably below industry standards for the whole 15-year period studied. The highest SO₂ level at KHB was 19.06 g/m³ in 2006. From the year 2017 until 2019, it has decreased by 89 percent, reaching 2 g/m³ and remaining steady. SO₂ levels in the Peenya region have been fluctuating.

Table 2 Industrial Areas: SO₂ Levels (Annual Average), EF and Air Quality Levels.

Year	Graphite India			KHB			Peenya		
	Levels	EF	Air quality	Levels	EF	Air quality	Levels	EF	Air quality
2004	8.75	0.18	L	10.00	0.20	L	9.28	0.19	L
2005	8.63	0.17	L	8.81	0.18	L	8.81	0.18	L
2006	22.52	0.45	L	19.06	0.38	L	17.78	0.36	L
2007	17.41	0.35	L	16.41	0.33	L	17.24	0.34	L
2008	15.48	0.31	L	14.71	0.29	L	14.92	0.30	L
2009	16.57	0.33	L	14.83	0.30	L	15.93	0.32	L
2010	16.50	0.33	L	14.60	0.29	L	15.43	0.31	L
2011	19.65	0.39	L	18.29	0.37	L	15.79	0.32	L
2012	16.21	0.32	L	15.55	0.31	L	15.61	0.31	L
2013	15.04	0.30	L	14.00	0.28	L	14.83	0.30	L
2014	14.57	0.29	L	12.85	0.26	L	14.24	0.28	L
2015	4.95	0.10	L	4.69	0.09	L	5.05	0.10	L
2016	3.80	0.08	L	3.60	0.07	L	2.00	0.04	L
2017	3.8	0.076	L	2	0.04	L	2	0.04	L
2018	2	0.04	L	2	0.04	L	2	0.04	L
2019	2	0.04	L	2	0.04	L	2	0.04	L

Standards: 50 µg/m³

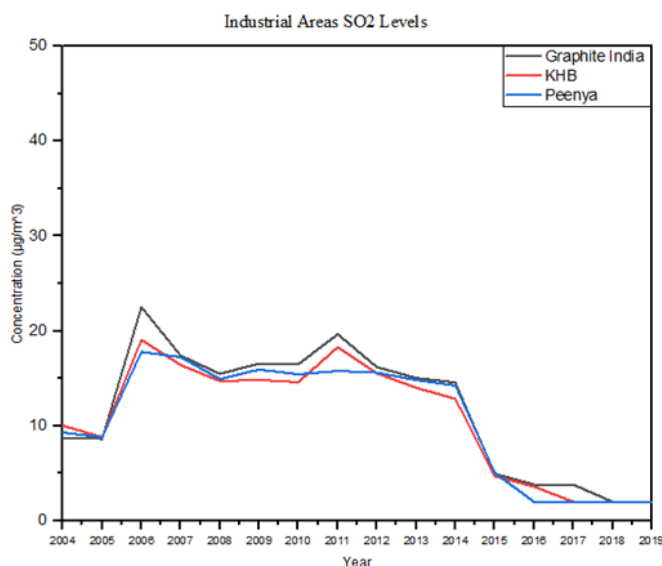


Figure 2 Industrial Areas: SO₂ Levels, EF and Air Quality Levels

Residential Areas

SO₂ levels in the residential areas, AMCO Batteries and Yeshwantpur are shown in the table 3 and figure 3. In AMCO Batteries, SO₂ levels in the year 2004 was 7.40µg/m³. It increased till the year 2006 by 139.8%. Later it started decreasing till the year 2010 by 20%. It increased in the year 2011 again by 12.88%. Later on it started decreasing again and reached 2µg/m³ in the year 2017 i.e. 87.5%. It remained constant since then till 2019. Yeshwantpur’s SO₂ levels in the year 2006 was found to be 17.93µg/m³ and decreased for the

following two years by 15.4%. It started increasing in the year 2009 and continued till 2011 when it reached 18.68 $\mu\text{g}/\text{m}^3$ i.e. by 23.13%. The highest level in the assumed period was in the year 2011. Since then the levels started decreasing and reached 2 $\mu\text{g}/\text{m}^3$ i.e. reduced by 89.29% in the year 2017. Since then the levels were constant till 2019.

Table 3 Residential Areas: SO₂ Levels (Annual Average), EF and Air Quality.

Year	AMCO batteries			Yeshwanthpur		
	Levels	EF	Air quality	Levels	EF	Air quality
2004	7.40	0.15	L	No Data	-	-
2005	8.75	0.17	L	No Data	-	-
2006	17.75	0.36	L	17.93	0.36	L
2007	16.85	0.34	L	16.64	0.33	L
2008	14.77	0.30	L	15.17	0.30	L
2009	14.88	0.30	L	16.08	0.32	L
2010	14.20	0.28	L	16.30	0.33	L
2011	16.03	0.32	L	18.68	0.37	L
2012	14.86	0.30	L	16.17	0.32	L
2013	14.50	0.29	L	14.32	0.29	L
2014	14.09	0.28	L	13.09	0.26	L
2015	5.09	0.10	L	4.81	0.10	L
2016	4.00	0.08	L	3.60	0.07	L
2017	2.00	0.04	L	2.00	0.04	L
2018	2.00	0.04	L	2.00	0.04	L
2019	2.00	0.04	L	2.00	0.04	L

Standards: 50 $\mu\text{g}/\text{m}^3$

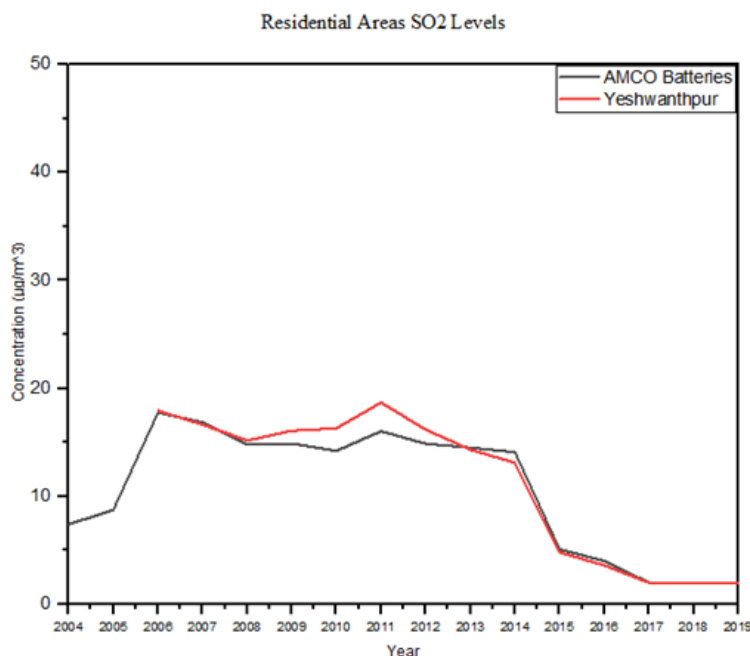


Figure 3 Residential Areas: SO₂ Levels, EF and Air Quality Levels.

Sensitive Areas

SO₂ levels in sensitive areas, Bangalore University and Victoria hospital are shown in the table 4. The SO₂ levels in the areas of Bangalore University was constant from the year 2011-2015 at 8.05µg/m³, no monitoring stations were available in the area to record data before 2011. This was the highest level recorded in this area. Later on it decreased by 52.79% as it touched 3.80µg/m³ in the year 2016. In the years 2017-2019 the area recorded the lowest value at 2µg/m³. The SO₂ level in Victoria hospital in the year 2004 was 7.52µg/m³ and it increased till the year 2006 by 138.16%. Later the trend decreased till the year 2011 by 30.48% and there was a slight increase in the year 2012 by 5.22%. From 2012-2017 it decreased drastically by 83.93% and has remained constant till 2019. The trend showed that the values fell below the prescribed levels of 20µg/m³.

Table 4 Sensitive Areas: SO₂ Levels (Annual Average), EF and Air Quality Levels.

Year	Bangalore university			Victoria hospital		
	Levels	EF	Air quality	Levels	EF	Air quality
2004	No Data	-	-	7.52	0.38	L
2005	No Data	-	-	9.04	0.45	L
2006	No Data	-	-	17.91	0.90	M
2007	No Data	-	-	16.77	0.84	M
2008	No Data	-	-	15.09	0.75	M
2009	No Data	-	-	14.39	0.72	M
2010	No Data	-	-	13.30	0.67	M
2011	8.05	0.40	L	12.45	0.62	M
2012	8.05	0.40	L	13.10	0.66	M

2013	8.05	0.40	L	12.59	0.63	M
2014	8.05	0.40	L	12.50	0.63	M
2015	8.05	0.40	L	4.83	0.24	L
2016	3.80	0.19	L	4.00	0.20	L
2017	2.00	0.10	L	2.00	0.10	L
2018	2.00	0.10	L	2.00	0.10	L
2019	2.00	0.10	L	2.00	0.10	L

Standards: 20 µg/m³

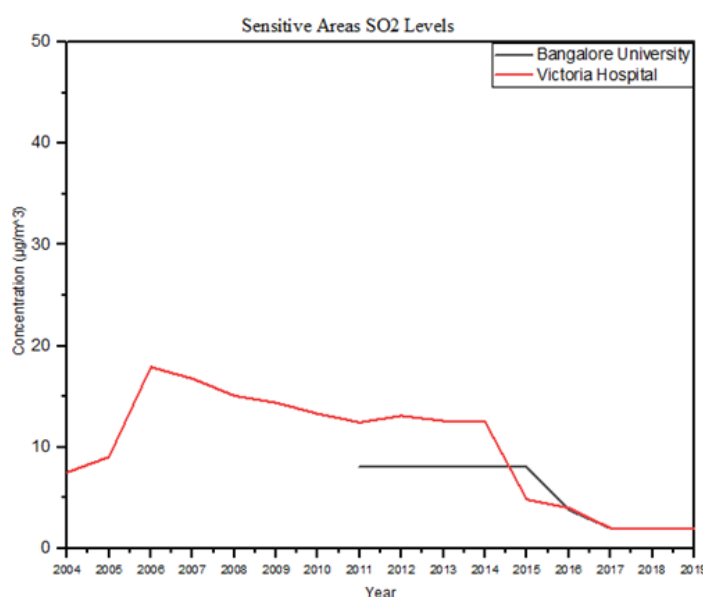


Figure 4 Sensitive Areas: SO₂ Levels, EF and Air Quality Levels.

5. Analysis of the Effectiveness of the Control Measures on SO₂ Levels

Trend of SO₂ pollutant in all the 3 areas have been gradually increasing from 2004 and has reached the peak in 2006. Four meetings were held in New Delhi by the CPCB in the year 2004 to make decisions on the ways to reduce the amount of pollutants in some of the most populated cities of India that included Bangalore. The following decisions were approved in those meetings,

Firstly approval for National Emission Standards for Pesticide manufacturing industry. Secondly approval for the Emission Standards for sulphuric acid plants. One such plant Srinivasa Industrial chemicals is located in Peenya was established in 1990. Lastly, Approval for effluent and emission standards for petroleum oil refineries. One such refinery is Bhuruka Gases Ltd, established in 1974 and located in Doddanekkundi Industrial area. After all the regulations were made, the amount of pollutants decreased in small amounts.

In the following year 2005, the sales of vehicles were increased by 14% as per Annual report KSPCB and there was an increase of SO₂ level in the residential and sensitive areas [12]. The amount of SO₂ was recorded the highest in 2006. This was mainly due to traffic congestion in Bangalore and the Bangalore Metropolitan Region Development Authority made a decision to spend 6000 crores on development of Arterial ring roads, radial roads and 30000 crores on townships coming up at Hosakote, Ramanagar, Magadi and Kanakapura.

In the year 2006, few decisions were made by the central board to reduce pollution in major polluted Indian cities as stated, the board had approved the Environmental Standards and Code of Practice for Pollution Prevention for Sponge Iron Plants. There's one such plant Prakash Sponge Iron Pvt Ltd located in Jayanagar. Also the board approved the proposal of National Emission Standards for Common Hazardous Waste Incinerator. To help Small Scale Industry units which have Diesel Generator Sets as the only source of power, the board had submitted proposal to Government to fix consent fee based on Kilo Volt Ampere rating rather than capital investment.

In the year 2007 the Control Board started funding to create awareness on pollution control. The board approved an expenditure of Rs. 1, 75, 000/- towards advertisements on televisions. Two such programs were aired on Doordarshan and India Today on how to control pollution in the environment.

The CPCB held another meeting on April 12, 2008, at which the following measures were announced: charging sampling and analysis fees for air quality analysis, limiting the storage duration for incinerable hazardous wastes by the Hazardous Waste Treatment, Storage, and Disposal Facility for Incineration Operators. These measures can be attributed to the decrease in pollution in the next years. Also a few months before the Deepavali festival which was celebrated on 17th October 2009 the KSPCB has displayed hoardings in all the districts in the State depicting the ill effect of bursting of crackers on environment and health of people. In spite of all these awareness measures on 21st October 2009 KSPCB reported an increase in air pollution by 7% from 15.48 $\mu\text{g}/\text{m}^3$ of the previous year to 16.57 $\mu\text{g}/\text{m}^3$ [13] during this festive season as compared to the previous year.

A major problem started when the amounts of pollutants started increasing again in the residential areas in following year 2010. The main reason was due to the pollutants released by the vehicles were increasing and in the year 2010 Bharat Stage III was introduced nationwide and soon the amount produced started decreasing in sensitive area in the year 2011, whereas in the industrial and residential areas the SO_2 levels increased lightly. Hence, the government made a decision to scrap vehicles that are more than 10 years old due to the increase in pollutants. Namma metro was introduced in the year 2011, which considerably reduced the amount of pollutants from vehicles [14].

In the year 2012, for the small scale industries installation of the Latest Pollution Control Systems was made mandatory [14]. Some types of air pollution control equipment used in the industrial applications are, air filters, electrostatic precipitators, scrubbers, cyclones, bio filters, mist collectors, incinerators and catalytic reactors. About 65, 00, 00 saplings were planted in the State to help greening of industrial areas and open spaces to create a green belt which acts as a Carbon sink, this success encouraged. The board, in the year 2011, had also encouraged Small Scale industries to adopt latest Pollution Control Systems by helping them to speed up the process of giving permissions and low interest loans.

In the same year Industrial sectors have been targeted for creating awareness and promoting Clean Development Mechanisms in order to better comply with pollution control legislation and to upgrade pollution control technologies. Plastics, dairy, hazardous waste recyclers, sponge iron and desiccated coconut industries were among the businesses covered. It also motivated Schools and NGO's to take up Greening initiatives. As the board achieved a success in the sapling plantation in the year 2011 encouraged KSPCB to mandate a condition to provide 33% of the entire project area of the industry to be utilised for green belt and therefore about 13, 47,583 saplings were planted in the year 2013- 2014 [15].

In 2013, the CPCB updated the list of Red, Orange, and Green category activities with the purpose of introducing uniformity in classification across the country and for the issuing of approval, and other approvals [15]. This was done in order to cut the pollution levels even more, and the results can be seen in figures 2, 3, and 4. Approval of the Development of Uniform National Air Quality Index and approval to revise the Environmental Standards for Brick Kilns were among the approvals made for the major polluted cities at a meeting held on June 26, 2014 by the Central Pollution Control Board to discuss strategies to

further reduce pollutants. A few similar kilns may be found in Bangalore, such as the Basant Brick Kiln in Sathyanarayana Nagar located in Sarjapur road, Keerthi Brick Works located in Bannerghatta Road.

In the year 2016 there was a decrease in the SO₂ trend. The Board has taken steps to outlaw individual incinerators within the city limits, as directed by the KSPCB, and has announced a fine of Rs. 25,000/- for each case of burning. [16]. The meeting of the Central Pollution control Board on 08-07-2016 paved way for the following initiatives, awareness programmes were conducted in Schools and public places like Malls, initiated by the Central Board with the help of the State Government across India, introduction and awareness creation on Eco- friendly Ganesh Festival and Deepavali.

In the year 2017, BS IV norms were enforced in the country which helped in decrease of SO₂ levels. SO₂ pollution drastically reduced in the year 2017. Another meeting was held on 06-05-2017 by CPCB to even more minimize the pollution and the following approvals were made: Approval of 'Pet Coke' as Approved Fuel under Section 2(d) of the Air (Prevention and Control of Pollution) Act, 1981. Pet cokes are used in electrical power plants and cement kilns. They are typically high in heating values and they don't produce ash when burnt. They are used as an alternative for coal because coal ash will be produced during the combustion of coal which is harmful when they settle in water bodies and also burning of coal leads to SO₂ pollution [17]. It can be concluded that due to control measures implemented by CPCB and KSPCB the levels of SO₂ pollutant for all the three areas in the period 2004-2019 were within the permissible limits of 50 µg/m³.

6. Conclusions

The data was grouped and sorted to get meaningful graphs and the trends were analysed. The following conclusions can be drawn from the analysis. Awareness creation has been the key to initiate the success of control measures. Making latest pollution control systems mandatory for small scale industries proved beneficial and it should be implemented on a wider scale. The plantation of sapling to act as a carbon sink was also beneficial. Research work on using alternative fuel to the conventional diesel, coal and petrol must be funded by KSPCB and CPCB which will prove beneficial on the longer run.

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Reduction of CO₂ emissions to decelerate and reverse global warming using mathematical analysis

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ABSTRACT

Understanding the problem of Future Global Carbon dioxide Emissions and arranging for the mitigation of these emissions through the regulation of human activities and the development of greenery in surroundings. This is to provide climate policy makers with smooth patterns of

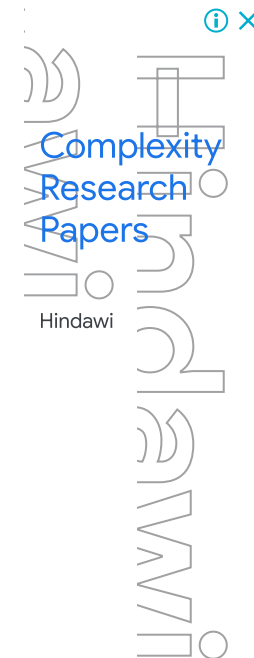


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mathematical approach to understand the problem. Global Warming is expressed in time to determine when the climate targets will be hit in case of no climate change mitigation. Based on secondary data using mathematical knowledge, this is an exponential model for the rapid reduction and long-term stabilization of CO₂ emissions slightly above zero. Then, suitable interpolations are performed to ensure a smooth and flexible transition to the exponential decline, further projecting the future CO₂ emissions status and take necessary remedial measures to control climate hence making the world a better Place.



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