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Assessment of Heavy Metals in Ambient Air in the Patancheru Area, Sangareddy District, Telangana

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Abstract: Patancheru is located in the North Western end of Hyderabad, located in Sangareddy district of Telangana State. It is an industrial zone located about 32 km from the city center on the Hyderabad-Solapur highway, and around 18 km from HITEC City. Patancheru is home to many pharmaceutical manufacturers along with residential and commercial areas as well as renowned institutions like ICRISAT and Indian Institute of Technology Patancheru is located at 17.53°N 78.27°E.[2] with an average elevation of 522 meters (1712 feet).[10] The area has more than 400 pharma industries manufacturing bulk drugs and active Pharma intermediates, besides mining activities. The area is also a corridor for IT industry with urbanization resulting in air, water and land pollution. The present paper deals with estimation of Heavy metals in ambient air through ICP-OES, a zone wise contribution of Heavy metals in ambient air in and around Patancheru area of Sangareddy district, from November 2023 to May, 2024 and correlation of the data with the CPCB, USEPA[9] & WHO standards. Air samples from 5 sampling stations were chosen. Ambient air samples collected using High Volume Air Sampler, Model 430 dxn. Heavy metal concentrations (Cd, Cr, Mn, Ni, Pb, As, Cu, Co, Fe, Al, V, Se) were analyzed using ICP-OES. Heavy metal contributions from industrial zone are observed to be higher than the residential and commercial zone and last and least is the sensitive zone.

Keywords: *Patancheru; Ambient Air; Industries; Pharmaceutical; Heavy Metals; Industrial; Residential.*

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I. INTRODUCTION

Patancheru, once a farming community, is now an industrial development zone. Environmental-action groups claims it has quickly become one of the most polluted places on earth. More than 300 factories pollute the air, land and water. Industrial waste is dumped in public places, fouling the atmosphere. (Patancheru journal by Dr. Rao Feb 6, 1991, sec. A, Page 4, an article[1]. In the air, heavy metals can accumulate from various sources like mining process, fossil fuels combustion, metallurgical process, incineration activities, industrial plants and windblown soil dust (Adani et al., 2015; Hassanien, 2009; Kampa and Castanas, 2008).[2] and also from anthropogenic activities.

During the past few decades industrialization, urbanization and modern agricultural practices with indiscriminate use of fertilizers and pesticides has resulted in degradation of environment. Respirable suspended particulate matter (RSPM), a significant component of air pollution, has drawn much attention due to its severe impacts on human health [3].

The sizes of heavy metals in ambient air, below 10 μm size can settle and retained inside the lungs which cannot be moved out of the lungs due to exhalation and inhalation process, which harm the human health (Chaudhari et al., 2012; Srivastava and Majumder, 2008; Hasan, 2008)[2]. Their entry into human's tissues and internal organs occurs through respiration, skin contact, ingestion and absorption and their concentration in air showed spatial variation based on distances to the sources. Their concentration levels are influenced by the speed and direction of the wind and seasonal variations (Gharaibeh et al., 2010)[2]. During outdoor activities, people can easily come into contact with airborne particulate matter which includes heavy metals..

Outdoor air pollution is a major problem worldwide due to its effects on human health. According to the World Health Organization [8], it was estimated that the effects of outdoor air pollution caused 4.2 million premature deaths worldwide in 2016 in urban and rural areas. Long-term exposure to ambient air pollution has exacerbated the pre-existing asthma and Chronic Obstructive Pulmonary Disorder (COPD) patients, increased risk of cardio pulmonary disease (range of conditions that affect the heart and lungs) and altered biochemical factors [4,]. The number of deaths attributed to PM_{10} exposure in Mumbai and Delhi rose to 32,014 and 48,651, respectively, in 2015, in comparison to 19,291 and 19,716 in 1995. Heavy metals, such as Lead (Pb), Cadmium (Cd), Nickel (Ni), Mercury (Hg), Arsenic (As), and others, can be hazardous even at low

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concentrations [3]. These metals can be released into the atmosphere by a number of human activities, including mining, industrial processes, emissions from vehicles, and the burning of fossil fuels [3]. People unknowingly breathe this harmful gases containing particle-bound heavy metals. As a result, long-term exposure shows detrimental consequences on their health. It is generally known that exposure to RSPM and the heavy metals that create health concerns. Additionally, it also impacts children's cognitive growth, lowering IQ, learning difficulties and behavioral issues [3].

The primary objective of this study is to assess, analyze and quantify the particulate-containing heavy metals, highlighting the need for air quality management. Further, it also provides valuable information for policy makers in environmental management of industrial, urban and semi-urban regions. The findings will serve as a basis for evidence-based policy development for mitigating heavy metal exposure and related human health impacts.

II. MATERIALS & METHODS

The most commonly used device is the High Volume Air Sampler, which consists essentially of a blower and a filter, and which is usually operated in a standard shelter to collect a 24 hour sample. This study was conducted in Patancheru area encompassing about 30 sq.km. These three regions were Pashmylaram and Bollaram (industrial zones), ICRISAT (residential cum commercial zone), Kandi (sensitive zone) and Hyderabad Central University as the back ground zone. In all 5 sampling sites were selected which cover the industrial zone, residential cum commercial zone, and sensitive zone.

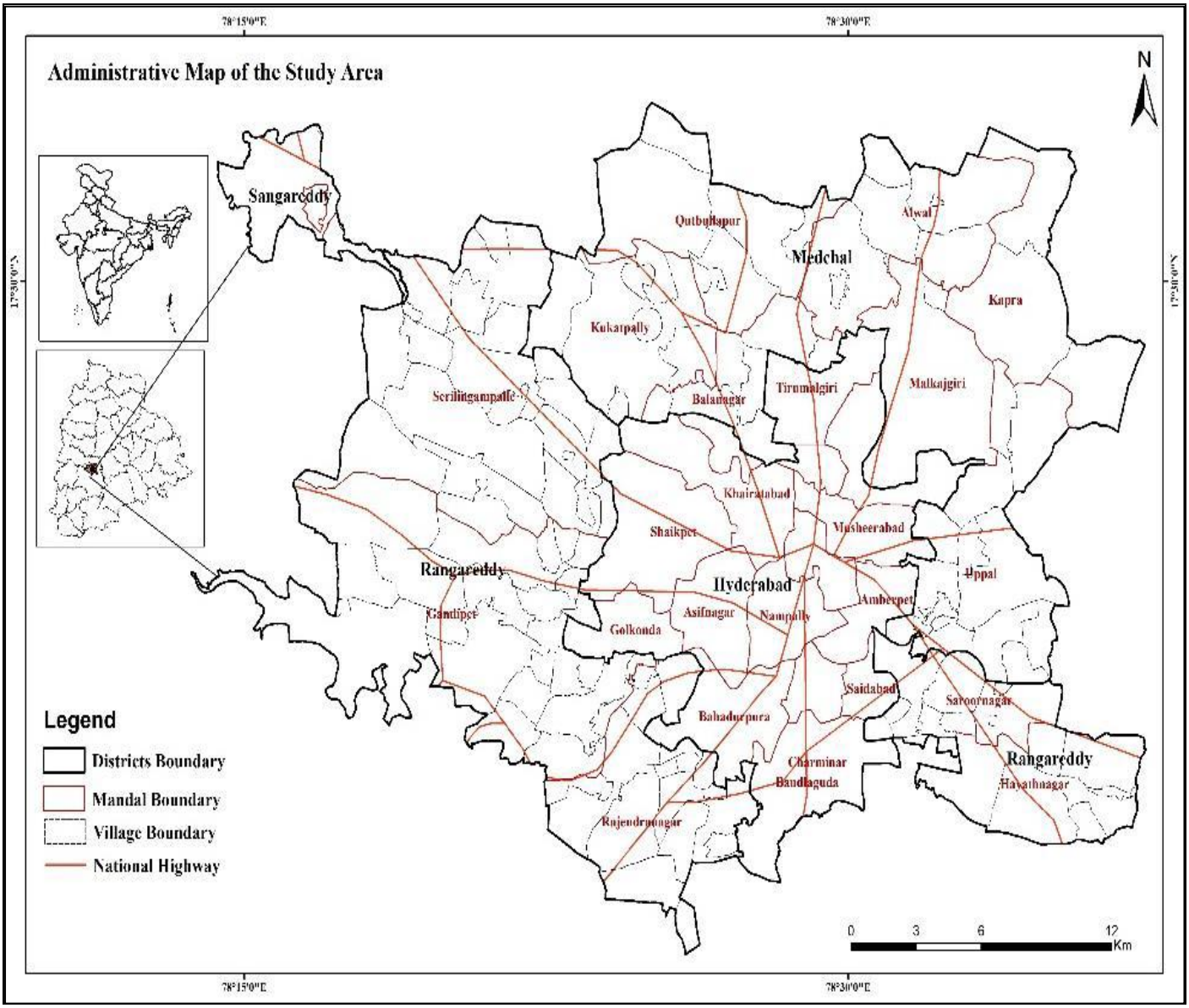

Fig 1: Location Map of the Study Area

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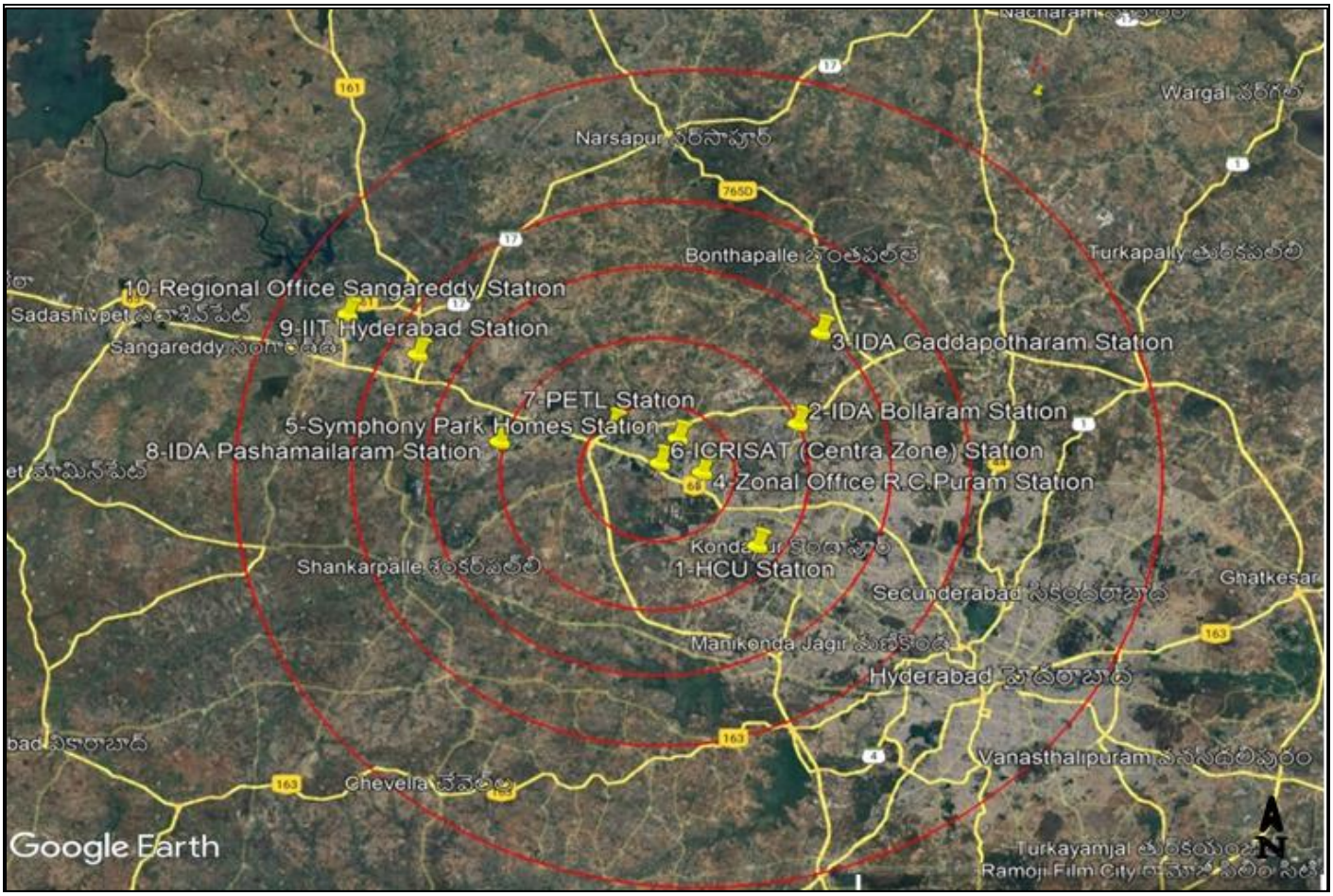

Fig 2: Sampling Point Deipicted on the Satellite Map. Patancheru

The study area Patancheru falls in Sangareddy district, Telangana state, covering an area of 246.16 sq.km with a population 2,29,447. There are 80 Red category industries, out of which 33 industries are in 17 - category which are categorized as highly polluting industries in the year 1980.

Today Patancheru is one of the fast developing Mandal with high construction activities as it is nearer to IT Hub, industrial Hub and for renowned Institutions, laid with connecting roads to Outer ring road and National High way. Due to the industrialization and growing urbanization, Patancheru suffers a heavy air pollution. As a result, the air quality degrades daily and increases health complications. Five sampling sites were selected in Patancheru area at CAAQMS stations i.e., Icrisat, Commercial and Residential zone, Pashmylaram and Bollaram (Industrial zones), IIT Kandi at Sangareddy district as Sensitive zone and Hyderabad Central University (Background Zone).

➢ *Air Sampling*

The Respirable suspended particulate matter (RSPM) was collected using a Respirable Dust sampler, No. APM – 460 – DXNL, Sl.No.298 R 186 – DTK – 2013 and its series, Make Envirotech instruments, New Delhi. Air is drawn at a flow rate of 1.1 l/min. for 24 hrs. on EPM2000, 20.3 X 25.4 cm (8 X 10 in) Glass Fiber filter paper. The sampler was set at a height (average 5.5 feet above the ground). Before and after sampling, the filter paper was kept in a desiccators (inside had activated silica crystal) for 48 hours to remove moisture from the filter paper and then the filter paper was weighed by Sartorius semi micro balance. The RDS (Flow rate, Time totaliser) and Rotametrer of gaseous sampling attachment instruments are calibrated through Envirotech services. All collected sample filter papers were adequately stored at 20˚C before further analysis. 2 samples for each station was collected one during winter seasons (end of December, January, and February and one in the summer (end of mid of March, April and May) during the period from December 2023 to May 2024. One sample is collected at Bollaram during winter season. Zone wise i.e., industrial, residential cum commercial and sensitive and one as the Background, total 9 samples were collected and one blank filter paper is taken as the sample and sampling was carried out as per the Central Pollution Control Board (CPCB) guidelines.[6]

➢ *Analysis of Trace Elements*

Extraction of Samples: The collected sample on glass fiber filters are extracted by Hot plate procedure: 1" x 8" strip or half the filter from the 8" x 10" filter is cut using a stainless steel pizza cutter. It is placed in a beaker using plastic forceps and dipped into the extraction solution (mixture of 3% HNO & 8% HCl). The beakers are placed on the hot-plate at Temperature below 80°C, contained in a fume hood, and refluxed gently while covered with a watch glass for 30 min. not allowing the samples to dry, removed the beakers from

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the hot-plate and cooled to room temperature. Rinsed the beaker walls and washed with distilled water. Again 10 ml extraction reagent is added to the remaining filter material in the beaker kept for 30 min then transferred it to a 100 ml volumetric flask and made up to the mark with rinses and distilled water and shaken well. The filtered sample is now ready for analysis. The matrix was stored in a well-cleaned polypropylene vials. and kept at20 ˚C until the analysis. A total of fifteen heavy metals, viz., Cd, Cr, Mn, Ni, Pb, and As, Zn, Mn, Co, Al, Mo, Cu, Fe, V, B, Se were analyzed using ICP- OES (Teledyne Leeman, Labs, Prodigy, S.No. 1063) as per the EPA method IO-3.5[5]. For obtaining metal concentrations, multi-element standard i.e., NSI Lab solutions, ICPQC standards 28 CRM (Certified Reference Material) used for calibration of the standards with R2 value of 0.999 is obtained, The limit of detection for all these metals is below 10ppb.

Table 1: Details of heavy Metals Concentration Sampling Station-Wise in **µg/m^3**

HEAVY METAL CONCENTRATION (µg/m^3)									
Filter Paper Code	**13577**	**88240**	**13551**	**16291**	**13576**	**88235**	**10089**	**13575**	**13594**
Date of Sampling	05-01-24	12-02-24	12-12-23	08-05-24	21-12-23	16-04-24	12-12-23	21-12-23	16-04-24
Station Name	HCU	HCU	ICRISAT	ICRISAT	Pashamailaram	Pashamailaram	Bollaram	IIT Kandi	IIT Kandi
Nickel (Ni)	0.005	0.001	0.006	0.006	0.009	0.004	0.023	0.006	0.001
Lead (Pb)	0.076	0.018	0.024	0.028	0.076	0.077	0.437	0.076	0.035
Zinc (Zn)	7.787	10.653	4.717	5.357	4.094	10.113	5.647	2.680	5.003
Arsenic (As)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manganese (Mn)	0.115	0.039	0.048	0.018	0.246	0.055	0.210	0.138	0.024
Chromium (Cr)	0.018	0.009	0.008	0.008	0.023	0.013	0.034	0.013	0.006
Cadmium (Cd)	0.006	0.001	0.000	0.000	0.025	0.006	0.003	0.008	0.003
Cobalt (Co)	0.005	0.013	0.001	0.004	0.003	0.010	0.010	0.000	0.004
Aluminium (Al)	0.111	0.039	0.048	0.018	0.247	0.057	0.212	0.136	0.025
Molybdenum (Mo)	0.045	0.000	0.000	0.000	0.009	0.005	0.033	0.011	0.000
Copper (Cu)	0.076	0.018	0.024	0.028	0.076	0.077	0.437	0.076	0.035
Iron (Fe)	2.345	1.369	0.687	0.538	3.143	1.285	7.217	2.941	0.668
Vanadium(V)	0.006	0.004	0.006	0.009	0.009	0.001	0.016	0.010	0.003
Boron (B)	1.431	3.007	0.628	0.776	0.502	2.535	0.886	0.266	0.712
Selenium(Se)	0.000	0.000	0.003	001	0.000	0.000	0.000	0.000	0.000

Table 2: Details of Heavy Metals Concentration Sampling Station-Wise in **ng/m^3**

HEAVY METAL CONCENTRATION (ng/m3)									
Filter Paper Code	13577	88240	13551	16291	13576	88235	10089	13575	13594
Date of Sampling	05-01-24	12-02-24	12-12-23	08-05-24	21-12-23	16-04-24	12-12-23	21-12-23	16-04-24
Station Name	HCU	HCU	ICRISAT	ICRISAT	Pashamailaram	Pashamailaram	Bollaram	IIT Kandi	IIT Kandi
Nickel (Ni)	5.096	1.286	6.369	6.313	8.838	3.859	22.727	6.313	1.263
Lead (Pb)	76.395	17.968	24.166	27.740	75.720	77.132	436.831	75.720	35.316
Zinc (Zn)	7786.879	10652.990	4716.815	5356.944	4094.318	10112.797	5647.348	2680.177	5003.409
Arsenic (As)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manganese (Mn)	114.624	38.559	48.382	17.652	246.187	55.280	209.571	137.601	23.965
Chromium (Cr)	17.803	8.971	7.611	7.544	22.696	12.830	34.059	12.595	6.282
Cadmium (Cd)	6.368	0.513	0.380	0.124	25.251	6.429	2.523	7.574	2.523
Cobalt (Co)	5.083	12.849	1.261	3.775	2.513	10.277	10.088	-0.013	3.775
Aluminium (Al)	110.825	38.583	48.405	17.674	247.472	56.589	212.119	136.361	25.250
Molybdenum (Mo)	44.586	0.386	0.000	0.000	8.838	5.145	32.828	11.364	0.000
Copper (Cu)	76.427	18.001	24.198	27.772	75.752	77.165	436.863	75.752	35.348
Iron (Fe)	2345.478	1368.746	686.879	538.131	3142.929	1285.145	7217.424	2940.909	668.182
Vanadium(V)	6.364	3.853	6.364	8.833	8.833	1.280	16.408	10.095	2.520
Boron (B)	1431.401	3006.624	627.580	776.073	502.083	2534.598	885.922	265.972	711.679
Selenium(Se)	0.000	0.000	2.548	0.631	0.000	0.000	0.000	0.000	0.000

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Table 3: Average of Heavy Metals Concentration–Sampling Station-Wise in µg/m^3

HEAVY METAL CONCENTRATION (µg/m3) IN PM10 from Dec-2023 to May-2024					
Station Name	**HCU**	**ICRISAT**	**Pashamailaram**	**Bollaram**	**IIT Kandi**
Nickel (Ni)	0.003	0.006	0.006	0.023	0.004
Lead (Pb)	0.047	0.026	0.076	0.437	0.056
Zinc (Zn)	9.220	5.037	7.104	5.647	3.842
Arsenic (As)	0.000	0.000	0.000	0.000	0.000
Manganese (Mn)	0.077	0.033	0.151	0.210	0.081
Chromium (Cr)	0.013	0.008	0.018	0.034	0.009
Cadmium (Cd)	0.003	0.000	0.016	0.003	0.005
Cobalt (Co)	0.009	0.003	0.006	0.010	0.002
Aluminium (Al)	0.075	0.033	0.152	0.212	0.081
Molybdenum (Mo)	0.022	0.000	0.007	0.033	0.006
Copper (Cu)	0.047	0.026	0.076	0.437	0.056
Iron (Fe)	1.857	0.613	2.214	7.217	1.805
Vanadium(V)	0.005	0.008	0.005	0.016	0.006
Boron (B)	2.219	0.702	1.518	0.886	0.489
Selenium(Se)	0.000	0.002	0.000	0.000	0.000

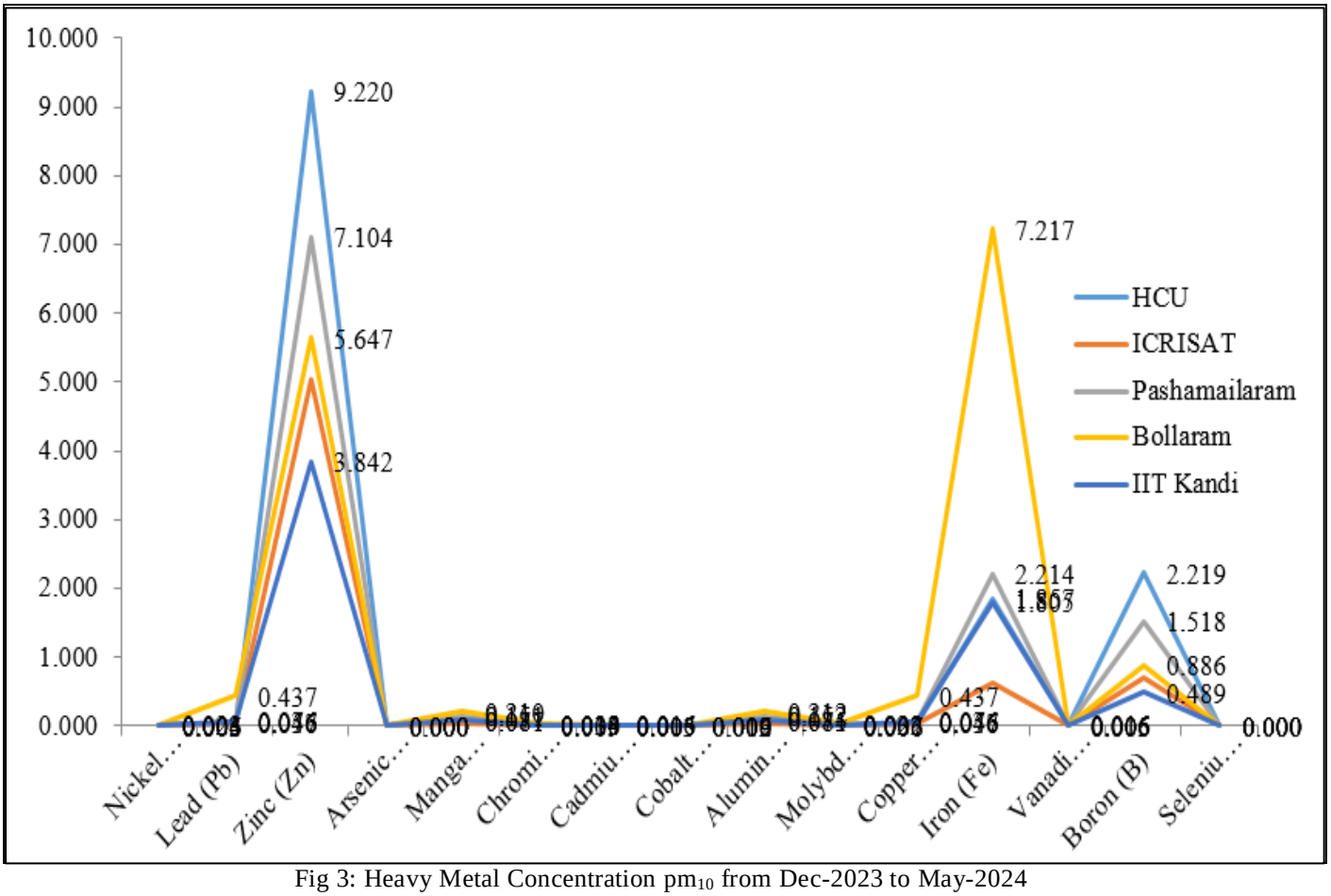

Fig 3: Heavy Metal Concentration pm_{10} from Dec-2023 to May-2024

III. RESULTS & DISCUSSIONS

The highest concentrations were identified for Zn < Fe < B along with Cd, Mn mostly identified in Bollaram, Pashmylaram industrial areas from various sources, may be due to the heavy industry process emissions and movements of heavy vehicles, and may be due to ongoing construction projects, and industrial activities, open burning of waste materials. The concentration for Iron (Fe) is observed in order of Bollaram > Pashamailaram > IIT Kandi > HCU > ICRISAT in comparison to the USEPA standards for Winter Season. Small concentrations of Lead and Copper are observed at Bollaram industrial area.

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Table 4: NAAQS Monitoring & Analysis as per the CPCB Guidelines Volume-I

NATIONAL AMBIENT AIR QUALITY STANDARDS (2009)				
Pollutants	**Time Weighted Average**	**Concentration in Ambient Air**		**Methods of Measurement**
		Industrial, Residential, Rural and other Areas	**Ecologically Sensitive Area (Notified by Central Government)**	
Lead (Pb) µg/m3	Annual * 24 Hours **	0.50 1.0	0.50 1.0	AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper-ED-XRF using Teflon filter
Arsenic (As), ng/m3	Annual *	6	6	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m3	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

Table 5: Heavy Metals (µg/m^3) in the Study Area as Per CPCB Standards

	HCU	ICRISAT	Pashamailaram	Bollaram	IIT Kandi	Standard
Nickel (Ni)	0.003	0.006	0.006	0.023	0.004	0.020
Lead (Pb)	0.047	0.026	0.076	0.437	0.056	1.000
Arsenic (As)	0.000	0.000	0.000	0.000	0.000	0.006

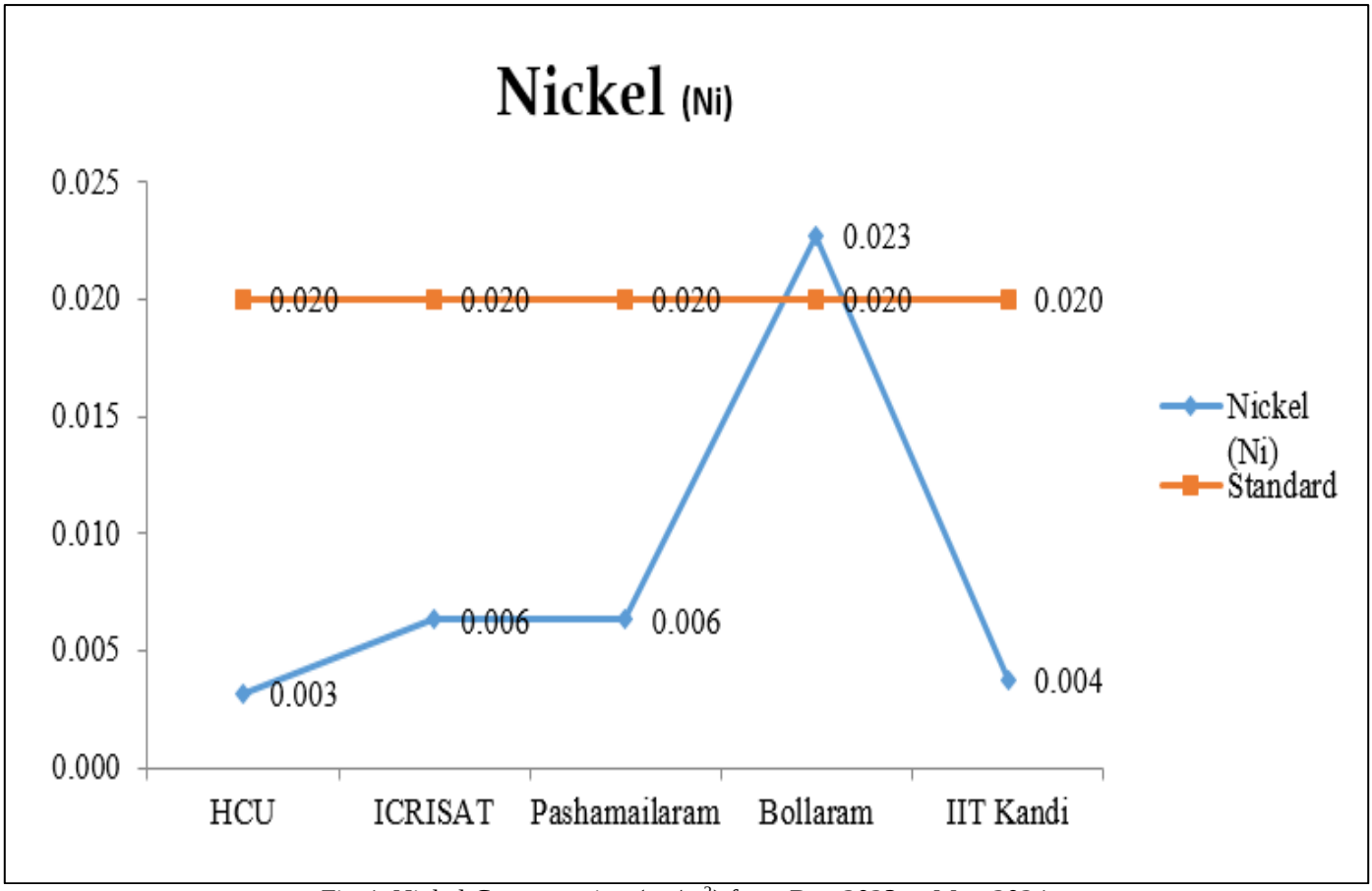

Fig 4: Nickel Concentration (µg/m^3) from Dec-2023 to May-2024

The Nickel concentration is reported to be 0.003 µg/m3 at Gachibowli i.e., considered to be background Zone (Control Station), and there is slightly at ICRISAT (Residential and Commercial Zone) and Pashmylaram industrial area. The concentration at IDA, Bollaram industrial Zone is increased to 0.023 µg/m3 which is greater than prescribed CPCB standard i.e., 0.020 µg/m3, May be due to industrial and vehicular emissions. At IIT Kandi, the reported concentration is 0.004 i.e., far less than prescribed CPCB standard i.e., 0.02, may be due to carried over from Industrial Zones and the is no activity near Kandi which can contribute Nickel pollutant.

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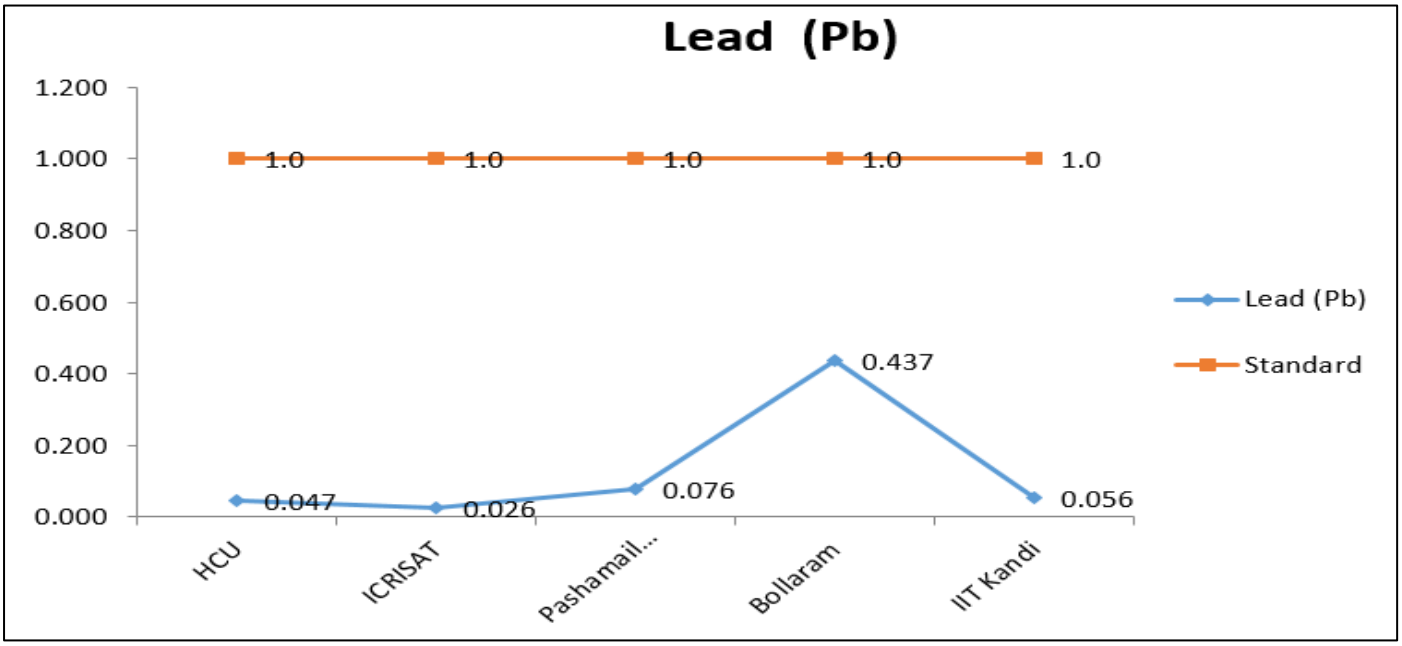

Fig 5: Lead (Pb) concentration (µg/m^3) from Dec-2023 to May-2024

The Lead concentration at all the stations is observed to be Less than the prescribed CPCB standards for 24 Hours i.e., 1.000 µg/m3. The concentration at Gachibowli Background Zone (Control Station) is observed to be 0.047 µg/m3 and it is decreased at ICRISAT, may be due to large open space with more dispersion, The concentration at Pashmylaram is increased slightly in comparison to the Background Zone because of Vehicular emissions as well as industrial process emissions, the concentration at Bollaram industrial Zone is increased to 0.437 µg/m3, May be due to process emissions from catalytic reactions and lead units as well as from Vehicular emissions. At IIT Kandi, the reported concentration is 0.056 i.e., far less than the prescribed 24hrs CPCB standard, may be due to carried over from Industrial Zones.

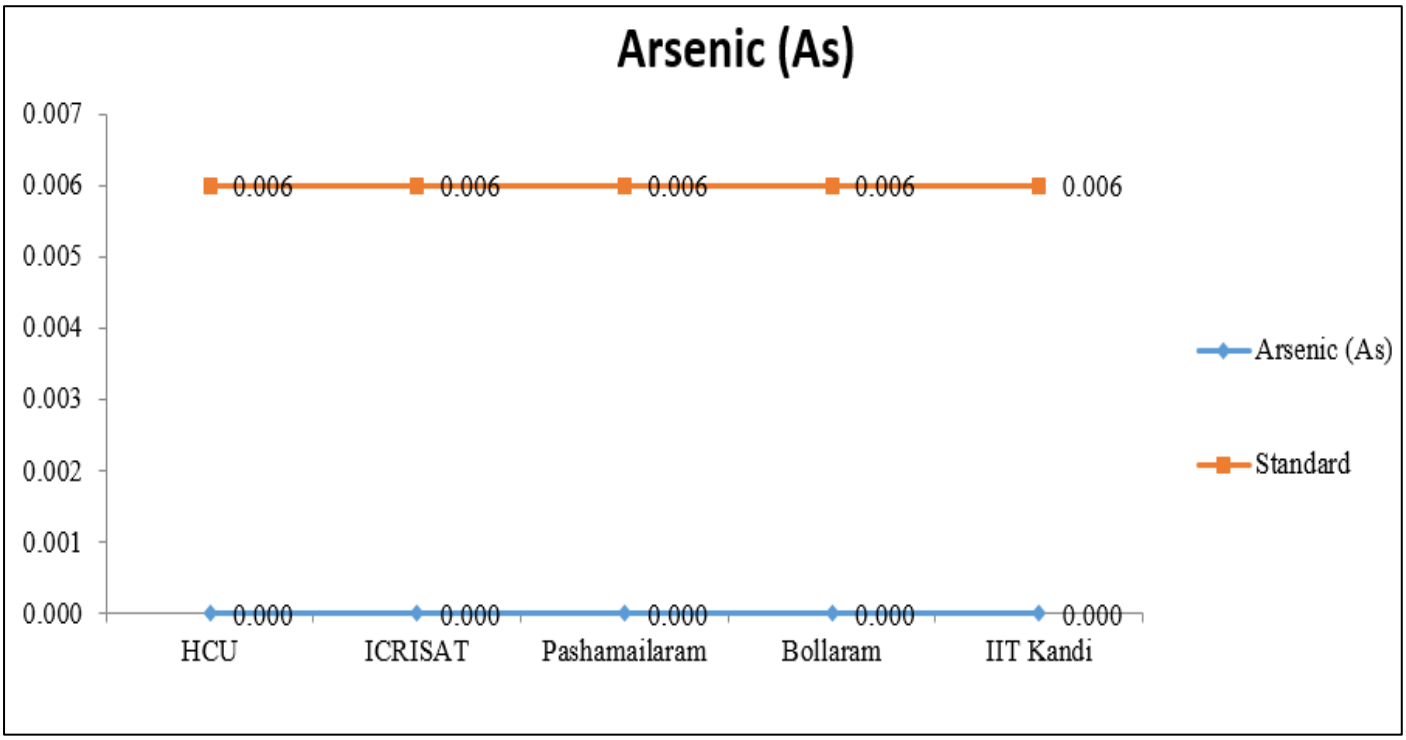

Fig 6: Arsenic Concentration (µg/m^3) from Dec-2023 to May-2024

The CPCB prescribed 24hrs & Annual standard for Arsenic is 0.006 µg/m3 and Not Detected in all monitoring zones, showing that there is no contribution of Arsenic.

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Table 6: Ambient Air Quality Standards (USEPA)

Metal	Winter (µg/m^3)	Summer (µg/m^3)	Limit Value (µg/m^3)
As	0.035	0.07	0.006
Cd	0.026	0.022	0.0002
Cr	0.354	0.309	0.012
Cu	0.2	0.2	100
Fe	4.3	3.4	10,000
Ni	0.067	0.061	0.00024
Pb	0.5	0.5	0.5

NAAQS: National Ambient Air Quality Standards; USEPA: United States Environmental Protection Agency; NIOSH: National Institute for Occupational Safety and Health. Source: Agarwal et al. [37].

Table 7: Heavy Metals Concentrations as Compared with the USEPA Standards during Winter Season (µg/m^3))

Heavy metals in the study area as per USEPA method.						
Date of Sampling	**05-01-2024**	**12-12-2023**	**21-12-2023**	**12-12-2023**	**21-12-2023**	**Seasonall**
Station Name	HCU	ICRISAT	Pashamailaram	Bollaram	IIT Kandi	Winter Standard
Arsenic (As)	0.000	0.000	0.000	0.000	0.000	0.035
Cadmium (Cd)	0.006	0.000	0.025	0.003	0.008	0.026
Copper (Cu)	0.076	0.024	0.076	0.437	0.076	0.200
Iron (Fe)	2.345	0.687	3.143	7.217	2.941	4.300
Nickel (Ni)	0.005	0.006	0.009	0.023	0.006	0.670
Lead (Pb)	0.076	0.024	0.076	0.437	0.076	0.500

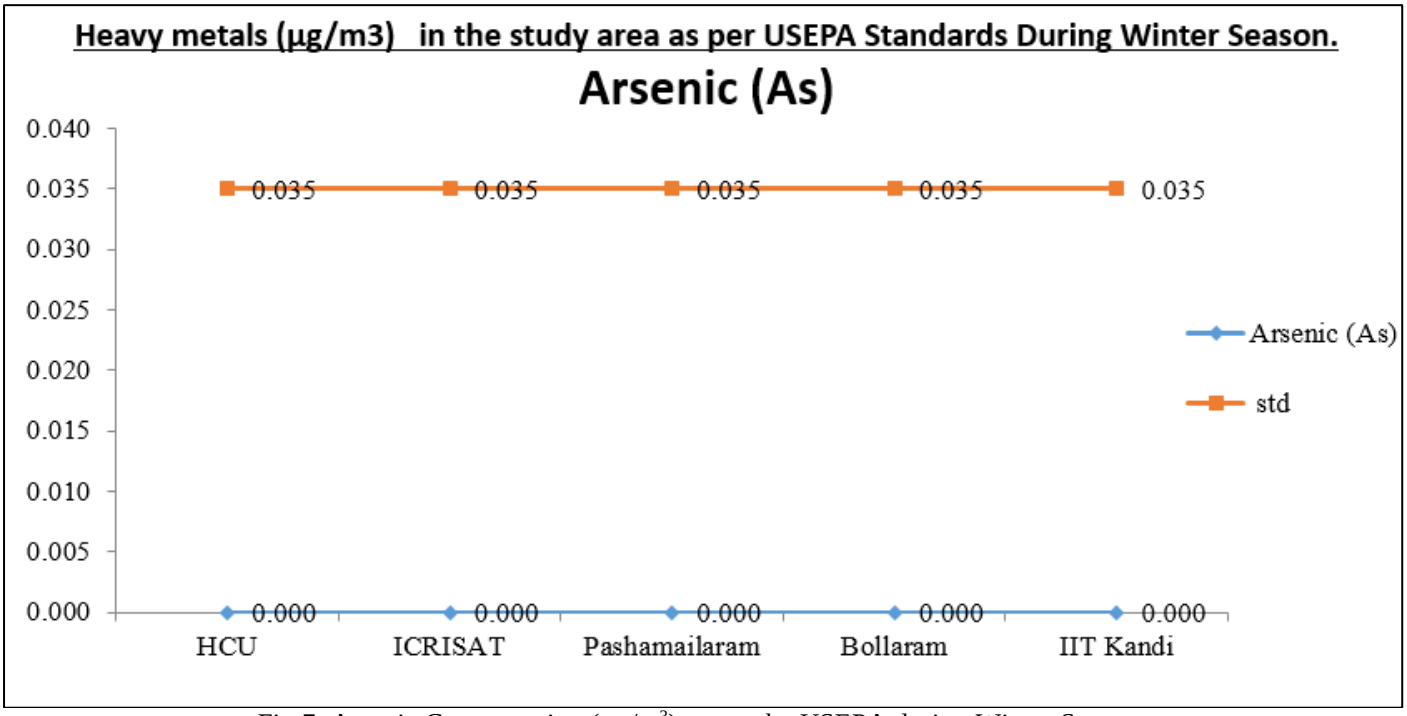

Fig 7: Arsenic Concentration (µg/m^3) as per the USEPA during Winter Season

The Arsenic concentration is reported as 0.0 at all zones showing that there is no contribution of Arsenic.

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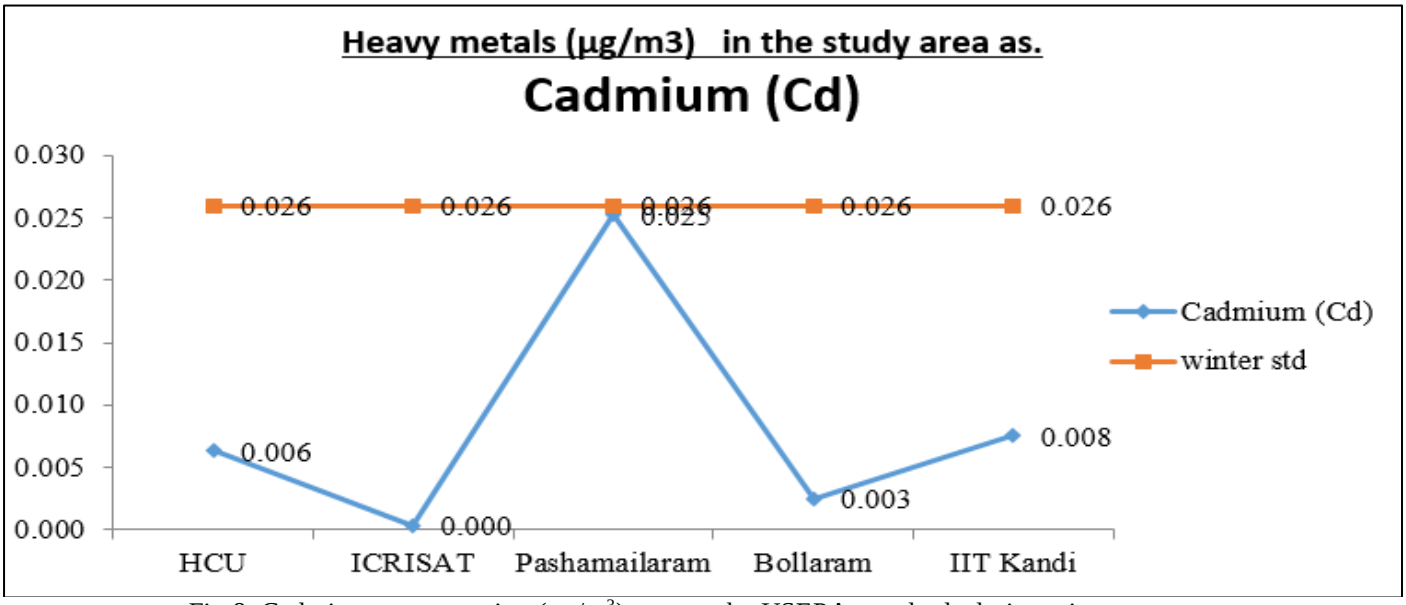

Fig.8. Cadmium concentration (µg/m^3) as per the USEPA standards during winter season.

The Cadmium concentration at all the stations is observed to be Less than the prescribed USEPA Standards During Winter Season i.e., 0.026µg/m3. However the small concentration of 0.006 µg/m3 is reported at Gachibowli i.e., Background Zone (Control Station), and it is not reported at ICRISAT, May be due to large open space and high dispersion, At Pashmylaram industrial area, the value noticed is 0.025 µg/m3,a closer value to the standard. may be due to industrial process emissions, the concentration at Bollaram industrial Zone is still decreased to 0.003, May be due to industrial process emissions from electroplating industries. At Kandi, the reported concentration is 0.008iµg/m3, which may be due to carried over from Industrial Zones.

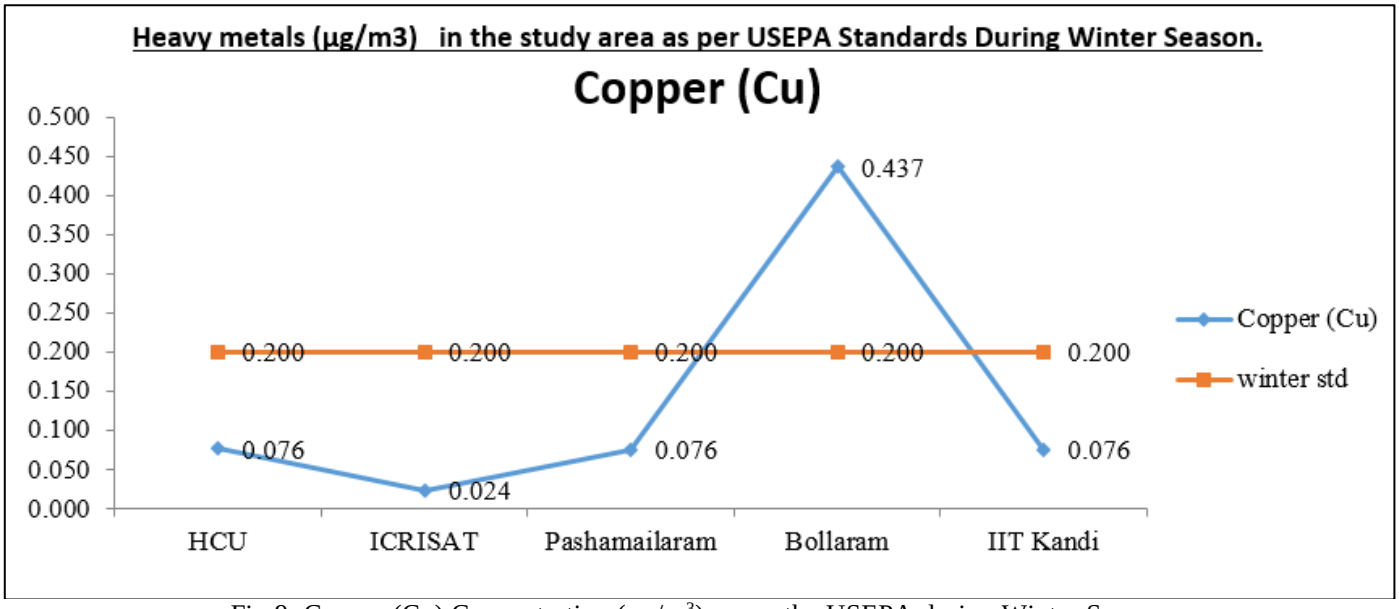

Fig 9: Copper (Cu) Concentration (µg/m^3) as per the USEPA during Winter Season

The Copper concentration at all the stations is observed to be Less than the prescribed USEPA Standards During Winter Season i.e., 0.20µg/m3 except for Bollaram industrial area, which is 0.437µg/m3 which may be contributed from industrial catalytic process emissions, Slight concentrations I,e. 0.076 µg/m3,are reported at Gachibowli i.e.,Background Zone (Control Station), 0.024 µg/m3 is reported at ICRISAT, May be due to large open space and high dispersion, Again 0.076 µg/m3concentration is noticed att Pashmylaram industrial area, may be because of industrial process emissions and the reported value at Kandi(sensitive zone), is also 0.076 µg/m3 iwhich may be carried over from Industrial Zones.

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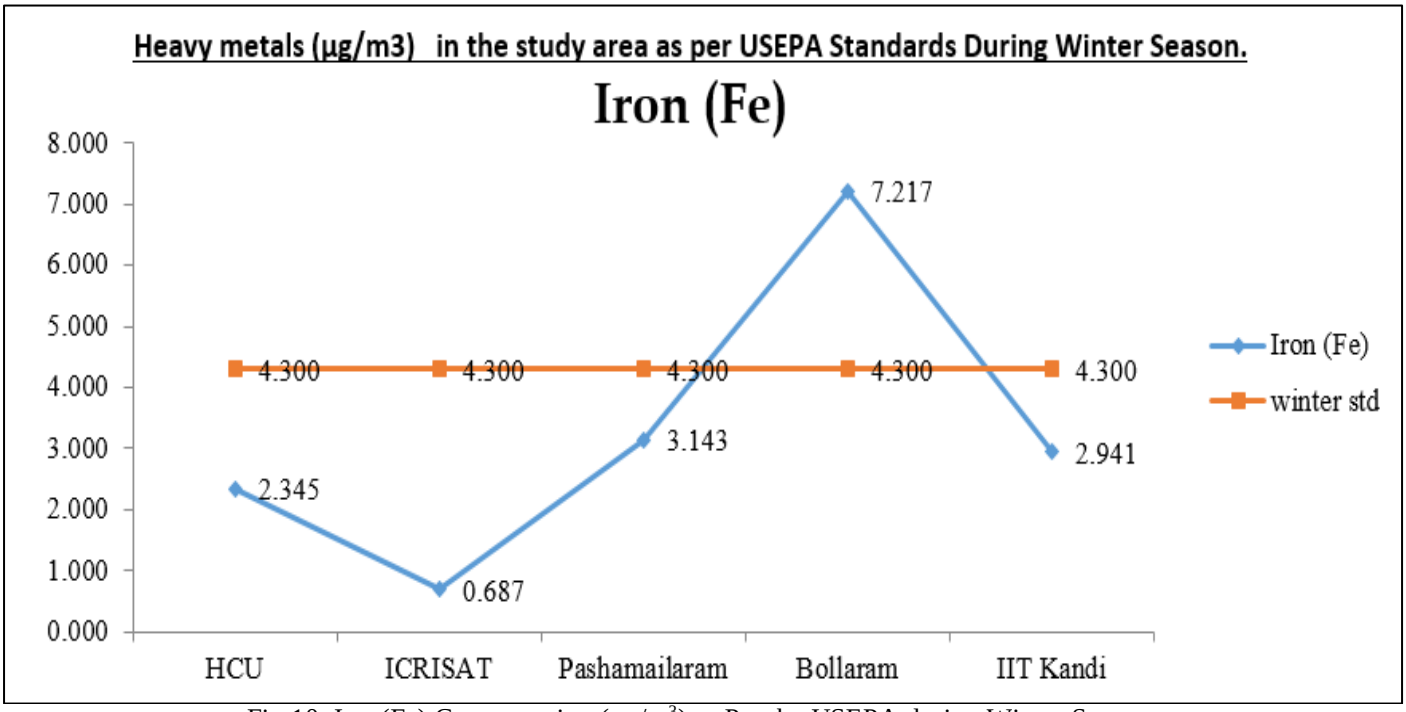

Fig 10: Iron(Fe) Concentration (µg/m^3) as Per the USEPA during Winter Season

The Iron concentration is observed to be 2.345 at HCU Background Zone(Control Station), may be due to vehicular emissions and open burning of waste materials and it is decreased at ICRISAT, May be due to large open space and hence due to less dispersion, The concentration at Pashmylaram is observed to be increased to 3.143 because of industrial process emissions and vehicular dust emissions, the concentration at Bollaram industrial Zone is still increased to 7.217 more than the standard value , May be due to process emissions from electroplating industries as well as vehicular dust emissions. At IIT Kandi, the reported concentration is 2.941 i.e., far less than 24hrs standard i.e., 4.3 µg/m3, may be due to carried over from Industrial Zone as well as vehicular dust emissions.

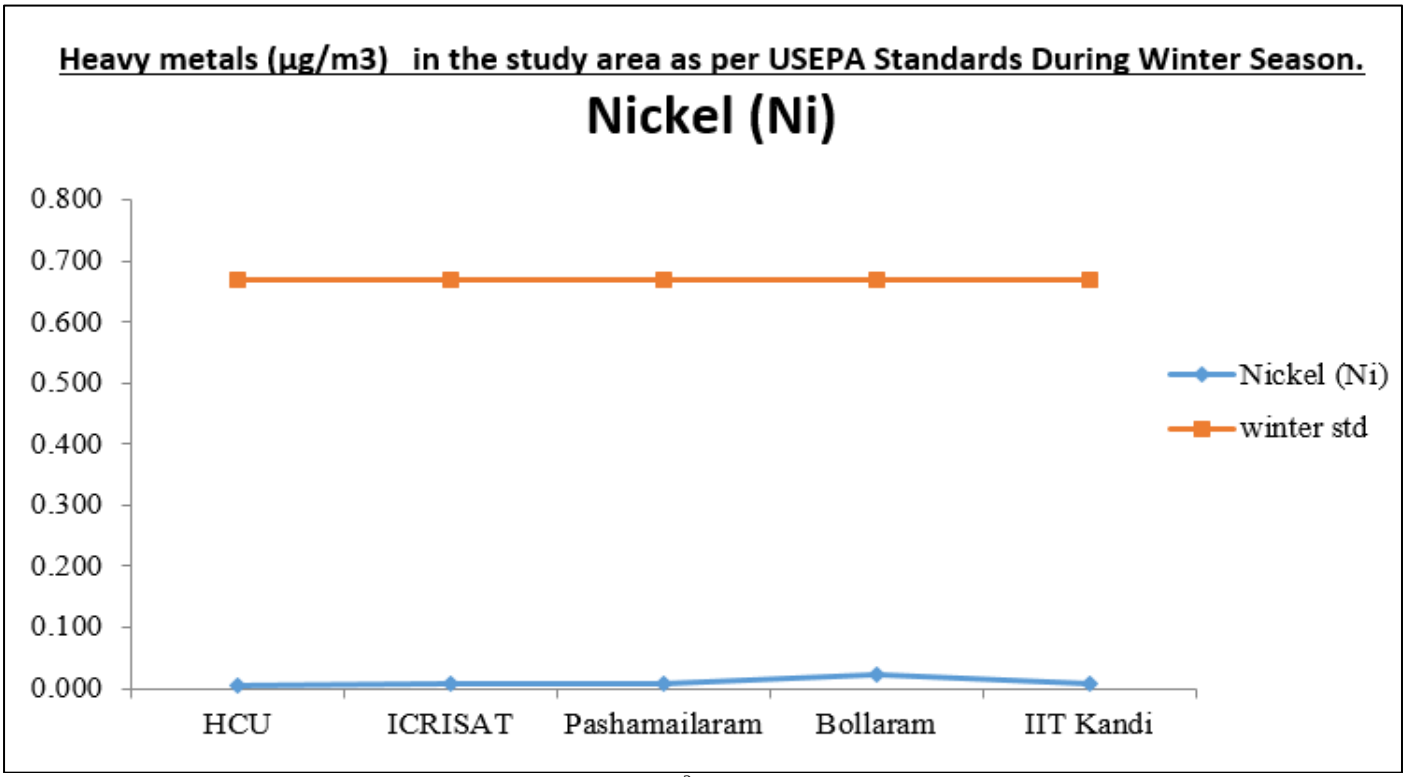

Fig 11: Nickel(Ni) Concentration (µg/m^3) as Per the USEPA during Winter Season

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The Nickel concentration is observed to be 0.005 at HCU Background Zone(Control Station), and there is slight increase at ICRISAT and same is observed at Pashmylaram industrial area may be due to Vehicular emissions, the concentration at Bollaram industrial Zone is increased to 0.023 ,May be due to process emissions from industries and Vehicular emissions. At IIT Kandi, the reported concentration is 0.006 i.e., far less than standard i.e., 0.5, may be due to carried over from Industrial Zones.

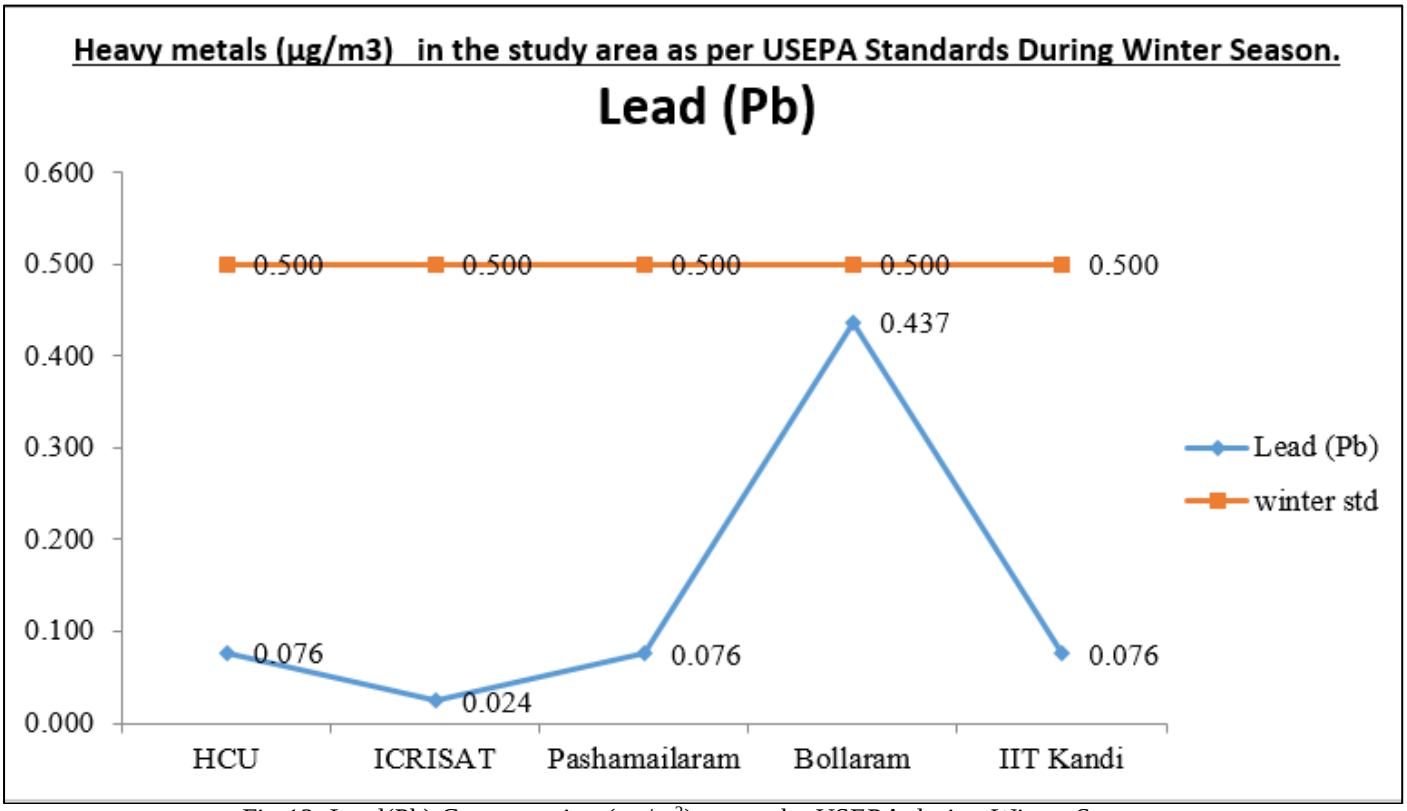

Fig 12: Lead(Pb) Concentration (µg/m^3) as per the USEPA during Winter Season

The Lead concentration is observed to be 0.076 at HCU Background Zone (Control Station), and it is decreased at ICRISAT, May be due to large open space and hence due to less dispersion, The concentration at Pashmylaram is observed to be increased because of Vehicular emissions as well as industrial process emissions, the concentration at Bollaram industrial Zone is increased to 0.437, May be due to process emissions from electroplating industries and Vehicular emissions. At IIT Kandi, the reported concentration is 0.076 i.e., far less than 24hrs standard i.e.,0.5µg/m3, may be due to carried over from Industrial Zones.

Table 8: Heavy Metals (µg/m3) in the Study Area as Per USEPA Standards during Summer Season

Station Name	HCU	ICRISAT	Pashamailaram	IIT Kandi	Standards
Arsenic (As)	0.000	0.000	0.000	0.000	0.070
Cadmium (Cd)	0.001	0.000	0.006	0.003	0.022
Copper (Cu)	0.018	0.028	0.077	0.035	0.200
Iron (Fe)	1.369	0.538	1.285	0.668	3.400
Nickel (Ni)	0.001	0.006	0.004	0.001	0.061
Lead (Pb)	0.018	0.028	0.077	0.035	0.500

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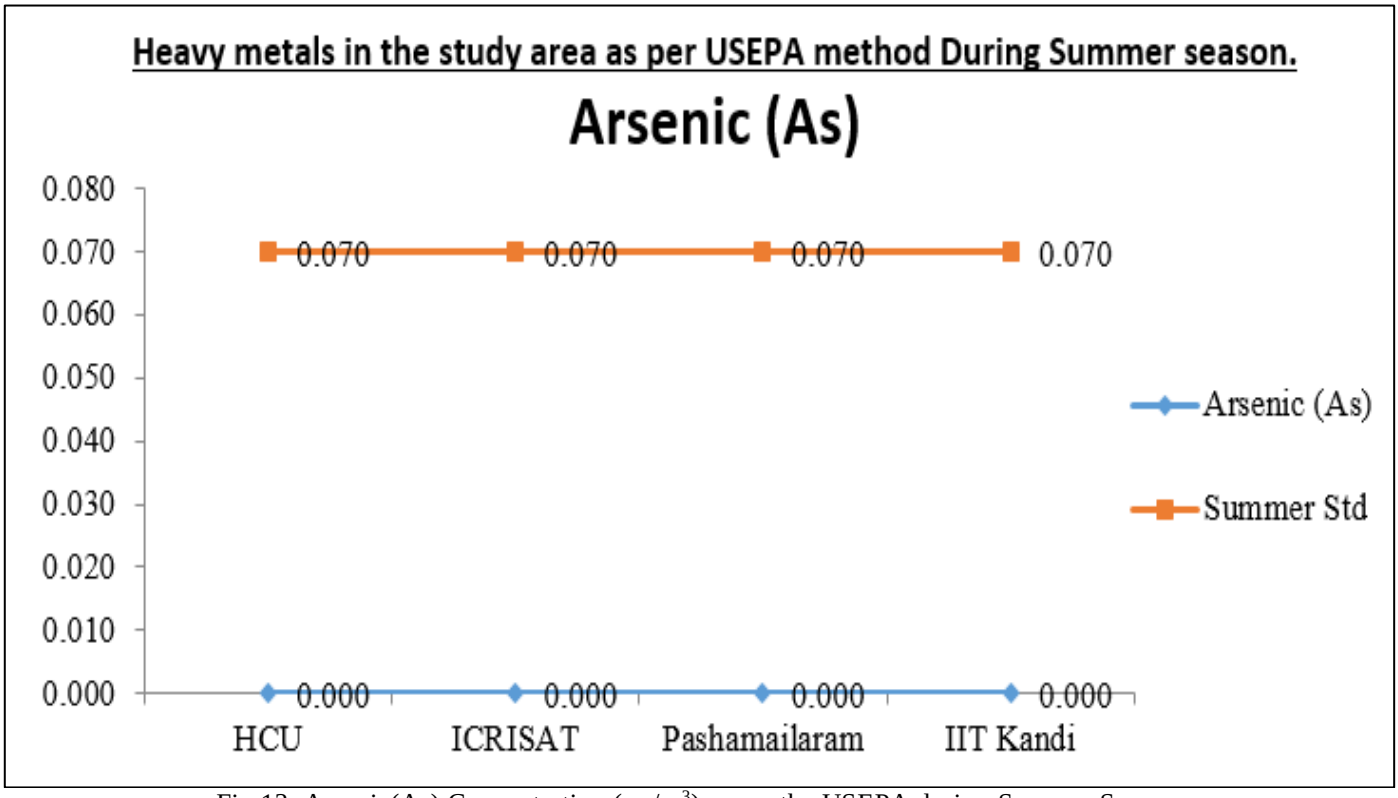

Fig 13: Arsenic(As) Concentration (µg/m^3) as per the USEPA during Summer Season

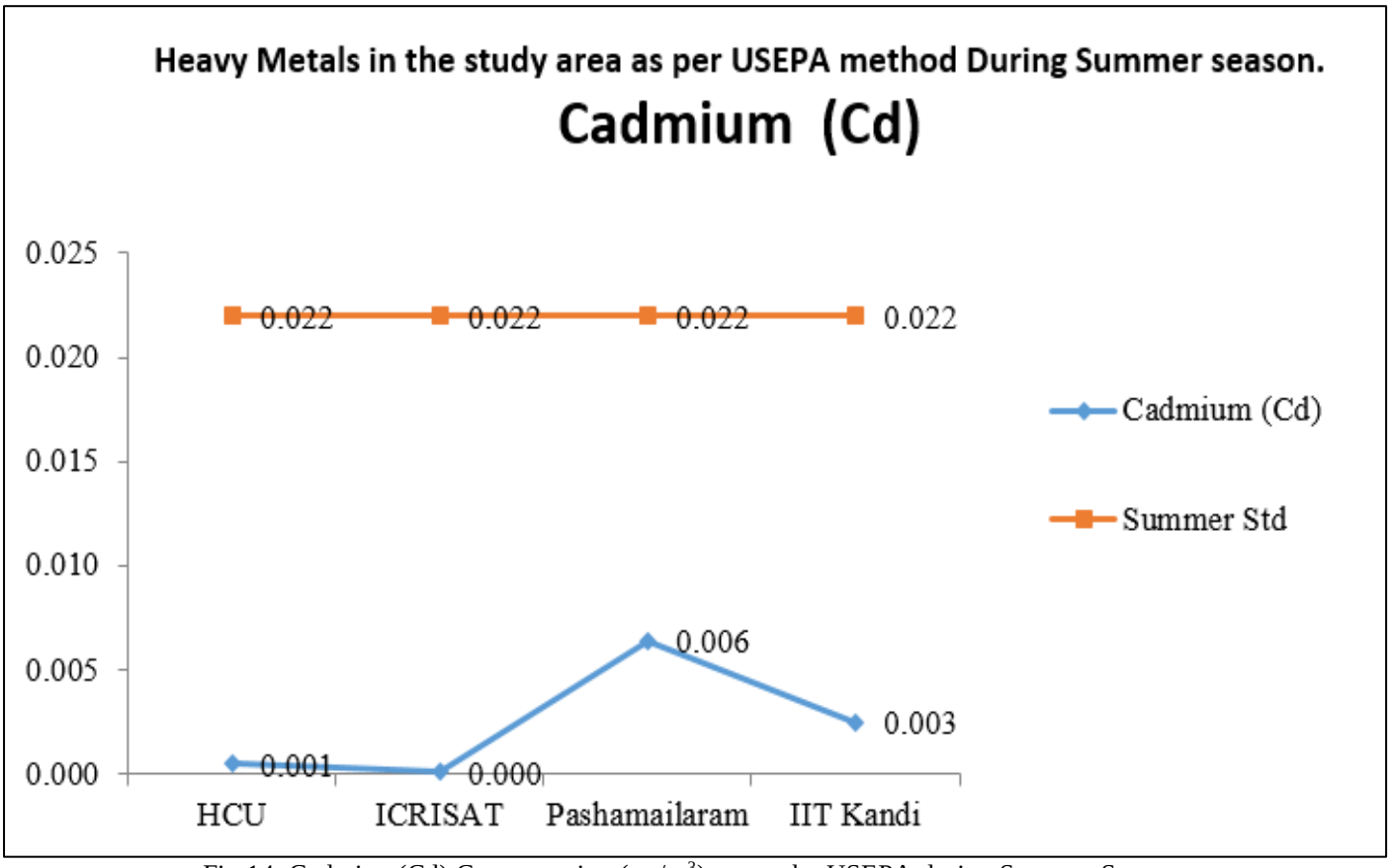

Fig 14: Cadmium(Cd) Concentration (µg/m^3) as per the USEPA during Summer Season

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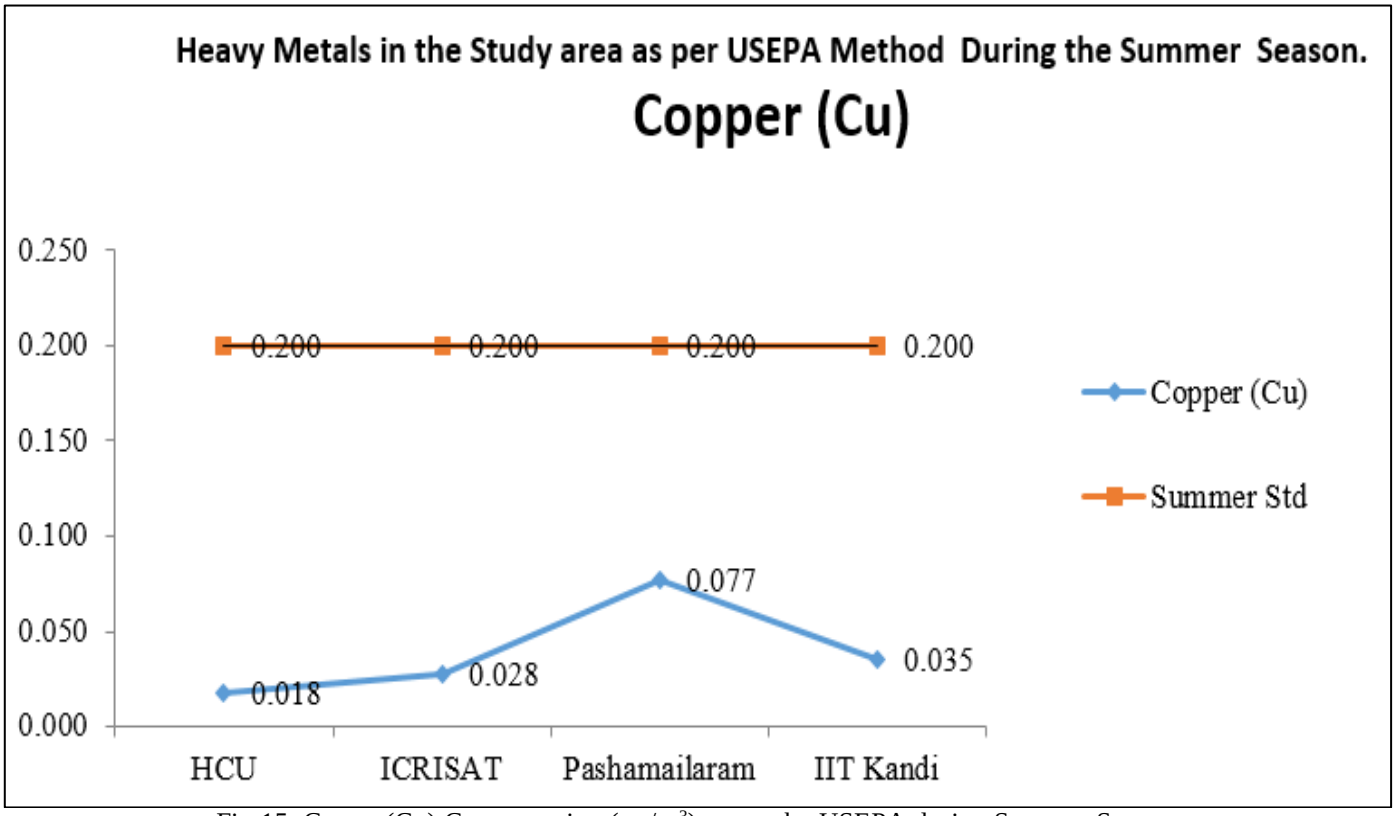

Fig 15: Copper(Cu) Concentration (µg/m^3) as per the USEPA during Summer Season

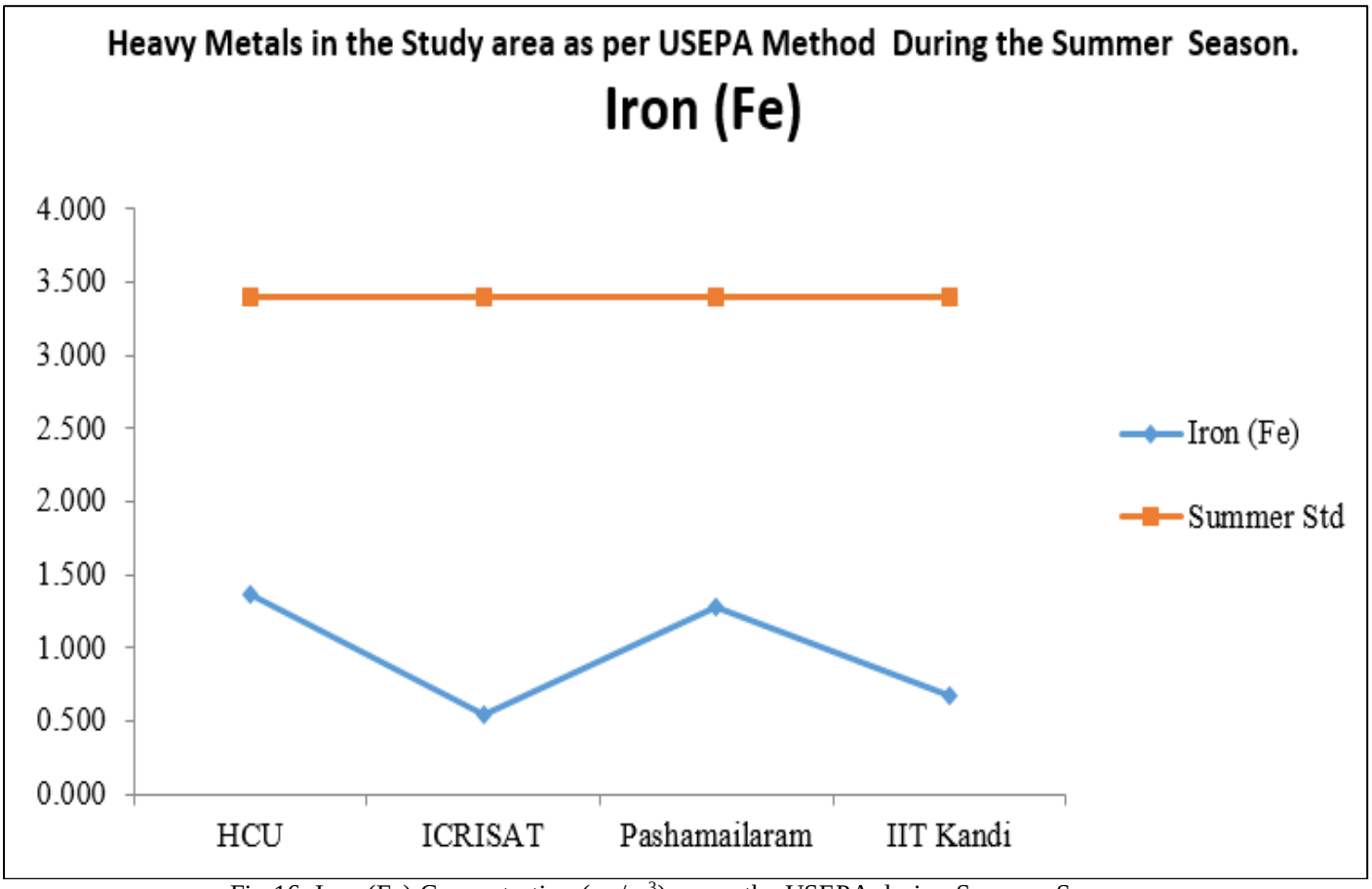

Fig 16: Iron (Fe) Concentration (µg/m^3) as per the USEPA during Summer Season

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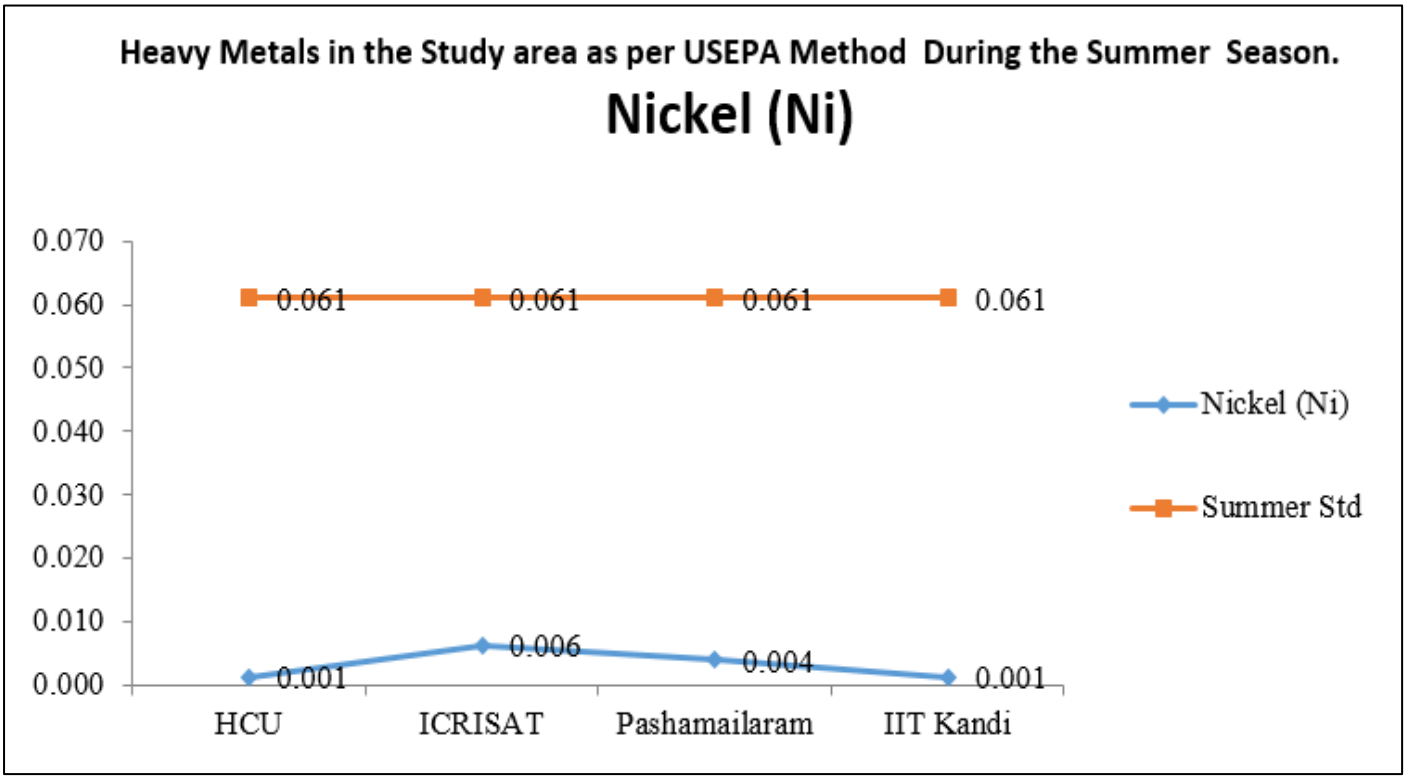

Fig 17: Nickel(Ni) Concentration (µg/m3) as per the USEPA during Summer Season

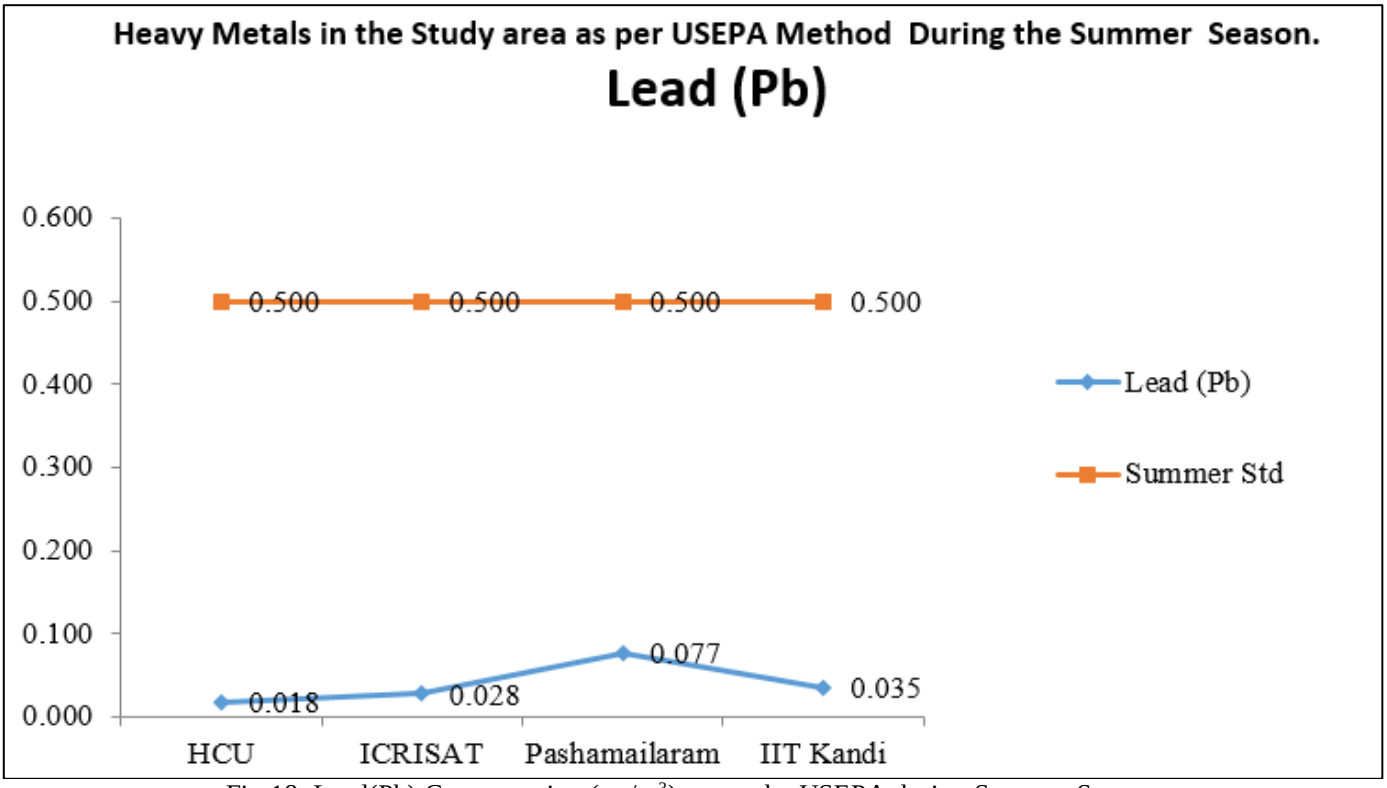

Fig 18: Lead(Pb) Concentration (µg/m^3) as per the USEPA during Summer Season

The concentration for Iron (Fe) is observed at Pashamailaram industrial area, HCU, IIT Kandi (Sensitive area) and Icrisat (Commercial cum residential) which is less than the USEPA standards for Summer Season. Other Metals are not identified much in the Commercial cum residential and sensitive area.

[3TheWorld Health Organization (WHO) has also designated heavy metals as hazardous air pollutants (HAPs); the recommended limits of Cd and Mn are 0respectively.6 Jan 20238]

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Table 8: Heavy Metals (µg/m3) in the Study Area as Per WHO

Heavy metals (µg/m3) in the study area as per WHO Standards						
	HCU	ICRISAT	Pashamailaram	Bollaram	IIT Kandi	Standard
Manganese (Mn)	0.077	0.033	0.1505	0.21	0.081	0.15
Cadmium (Cd)	0.0035	0.00	0.0155	0.003	0.0055	0.005

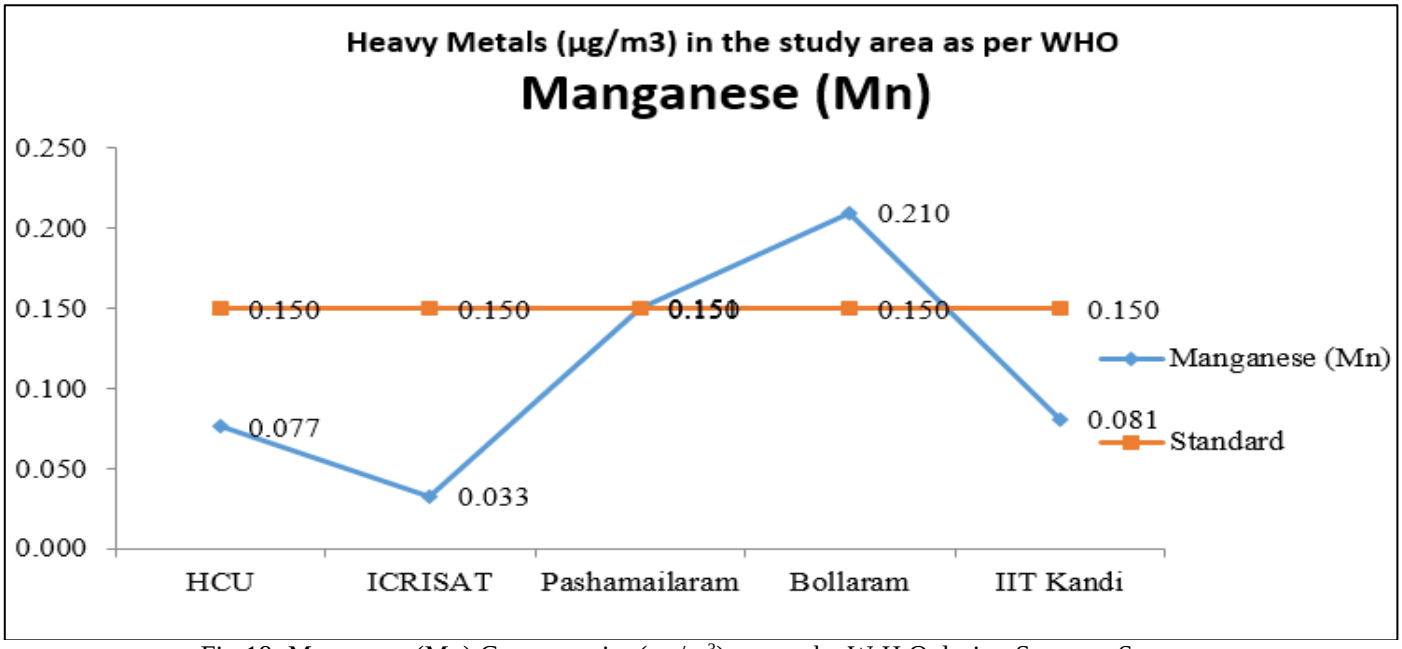

Fig 19: Manganese(Mn) Concentration(µg/m^3) as per the W.H.O during Summer Season

The Manganese concentration is observed to be 0.077 at HCU Background Zone (Control Station), may be due to vehicular emissions and open burning of waste materials and it is decreased at ICRISAT, May be due to large open space and hence due to less dispersion, The concentration at Pashmylaram is observed to be increased to 0.151 which is equal to standard because of industrial process emissions, the concentration at Bollaram industrial Zone is still increased to 0.210 i.e., more than the standard value, May be due to process emissions from electroplating industries as well as vehicular dust emissions. At IIT Kandi, the reported concentration is 0.081 i.e., the value may be due to carried over from Industrial Zone.

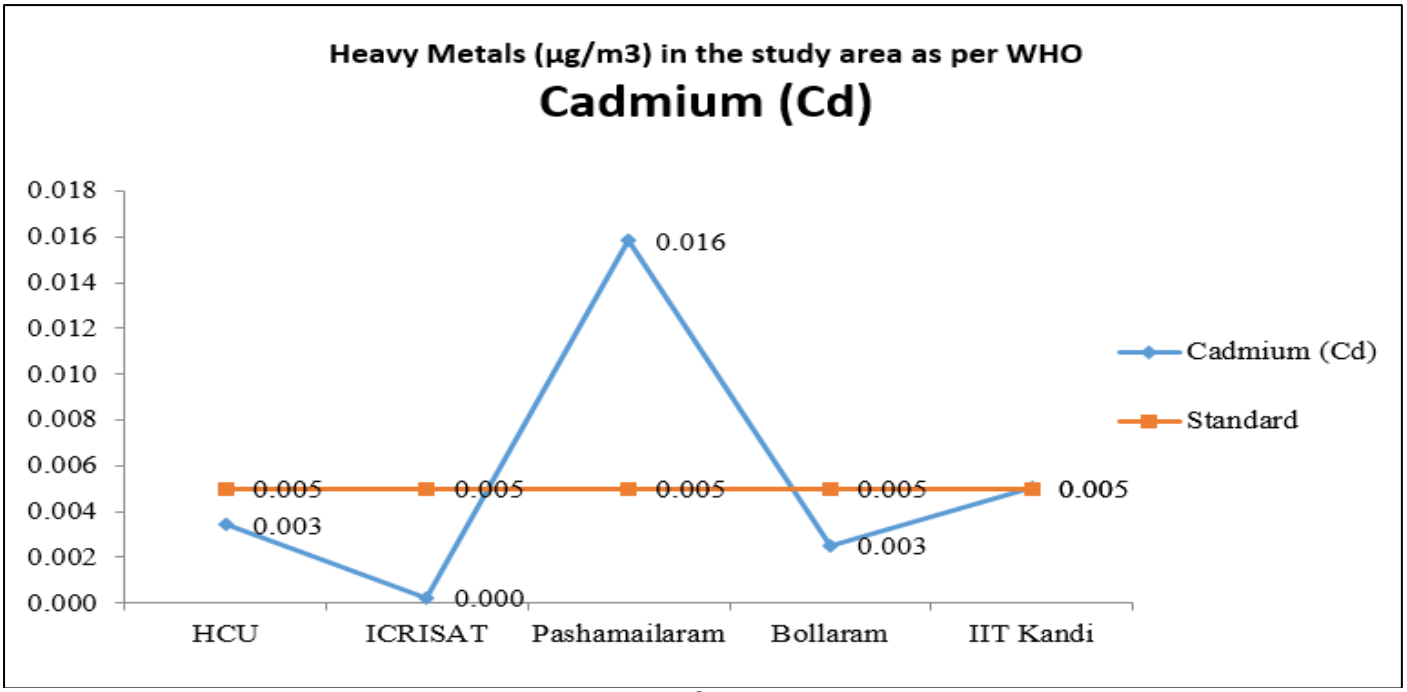

Fig 20: Cadmium(Cd) concentration(µg/m^3) as per the W.H.O during Summer season

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The Cadmium concentration is observed to be 0.003 at HCU Background Zone (Control Station), may be due to vehicular emissions and open burning of waste materials and it is decreased at ICRISAT, May be due to large open space and hence due to less dispersion, The concentration at Pashmylaram is observed to be increased to 0.016 because of industrial process emissions, the concentration at Bollaram industrial Zone is still decreased to 0.003 less than the standard value, May be due to process emissions from electroplating industries as well as vehicular dust emissions. At IIT Kandi, the reported concentration is 0.005 i.e., The threshold value of the standard may be due to carried over from Industrial Zone.

IV. CONCLUSIONS

The Heavy metals, one of the air pollutants are carried over in wind direction from upwind to downwind including crosswind directions towards the sensitive zone. The Heavy Metal concentrations are reported in the decreasing order from Gachibowli to Kandi i.e.,in the order of: Gachbowli→Ramachandrapuram→Industrial Zones (Pashmylarm in down wind and Bollaram in crosswind directions)→Kandi, Sangareddy. The concentrations of most of the pollutants are reported far below the standards. At ICRISAT (Residential and Commercial Zone) the concentrations of Heavy metals are reported below the PCB, USEPA AND W.H.O STANDARDS and sometimes not detected, may be due to the open area and high dispersion. As per the CPCB standards all the pollutants are reported within the limits except for Nickel at Bollaram Industrial area.As per the USEPA Standards during Winter Season the concentrations of Iron and Copper at Bollaram Industrial area are reported higher than the standards. As per the USEPA Standards during Summer Season, the concentration of all the Heavy metals are reported within the limits indicating more dispersion in comparison to the winter season. As per the WHO standards the pollutants prescribed are Mn & Cd. The Manganese at Bollaram and Cadmium at Pashamailaram Industrial Zones are reported exceeding the limits. At Kandi, the Sensitive Zone, the pollutants are reported in considerable concentrations which may be carried over from upwind direction.

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