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Vehicular pollution in Jammu city: Implications on environment and health

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***Abstract*---**There is a close relationship between environment and life because destruction of the environment would lead to the destruction of all the living creatures, including human beings. Regrettably, recent years have witnessed an unprecedented industrial and technological advancement which on one side may be of great benefit for human welfare but has brought in its wake colossal problem of environmental pollution. The dawn of the 20th century brought a new kind of air pollution in its wake due to the modernization of the transportation system and the large-scale use of petrol and diesel as fuels. Motor vehicles are a significant source of urban air pollution and are increasingly important contributors of various anthropogenic pollutants having deleterious effect on environment and human health. The vehicular pollution assumes special significance in Jammu city owing to constant increase in level of air pollutants resulting in its categorisation under 'non-attainment' city and a rapid increase in the fleet of vehicles moves in and around the city. Numerous national and international studies revealed the growth of diseases in the last few years, and the impact on life expectancy rate of Jammuites due to breathing polluted air. All these factors indicate that vehicular pollution has become a major problem in Jammu city and there is an essential need to build up healthy environment and augment the mitigation strategies by regulatory agencies to contain it at the earliest. The present study is a review of an increase in vehicular pollution in Jammu city and its effect on human health and environment due to increasing vehicular population.

***Keywords*---**Vehicular pollution, Health, Environment, Traffic congestion, J&K Pollution Control Board, Jammu City.

Introduction

Nature is a synthesis of five elements- air, water, soil, fire and ether and man had been living in harmony with nature since times immemorial. But his necessities, his material knowledge, his desires, his newly-developed values largely determined the changes and challenges that he brought about in vis-à-vis his relationship with nature. There is a close relationship between environment and life because destruction of the environment would lead to the destruction of all the living creatures, including human beings. Regrettably, recent years have witnessed an unprecedented industrial and technological advancement which on one side may be of great benefit for human welfare but has brought in its wake colossal problem of environmental pollution. Issues such as global warming and climate change, ozone depletion, acid rain, deforestation, desertification, toxic wastes and loss of biological diversity have resulted in increasing global awareness of the problems facing the planet Earth. An unprecedented rise in human population has overburdened ecological and social systems. The dawn of the 20th century brought a new kind of air pollution in its wake due to the modernization of the transportation system and the large-scale use of petrol and diesel as fuels. Industries and vehicles are the biggest sources of air pollution in Indian settings.* Though we lag behind the developed nations in terms of Industrialization, motorization and urbanization, yet we are still the third- largest country in greenhouse gas emission after China and United Nations.† So, we can be sure that pollution will grow by leaps and bounds unless significant efforts are undertaken to control it.

Air pollution is a public health emergency in India. About 1.7 million deaths were attributable to air pollution in the country in 2019, which was 18 per cent of the total deaths in the country, while the economic loss due to the lost output from premature deaths and morbidity from air pollution was 1.4 per cent of the GDP in India during this time, which is equivalent to Rs. 2, 60,000 crore.‡ India's poor score on environment performance index in 2020 also suggests the need to re-double national sustainability efforts with a high- priority to critical issues such as air and water quality, biodiversity and climate change.§
Most notably, worsening air quality has also pushed the Jammu and Srinagar cities in the category of non-attainment cities. J&K is the 19th biggest contributor of the greenhouse gases in the country.**As per the Central Pollution Control Board, Jammu and Srinagar cities have the level of air pollutants towards higher side and as such violate the standard permissible limits. As a consequence, these cities figure at Serial No.28 and 29 respectively in the list of a total of 104 non-

1. Air pollution in Indian Cities: Understanding the causes and the knowledge gaps, *available at:* https://www.cprindia.org/news/air-pollution-indian-cities-understanding-causes-and-knowledge-gaps (last visited on December 9, 2021).
2. Report: China emissions exceed all developed nations combined, *available at:* https://www.bbc.com/news/world-asia-57018837 (last visited on Dec. 9, 2021).
3. Bindu ShajanPerappadan,"1.7 million deaths in India were attributable to air pollution in 2019" *The Hindu,* Dec. 22, 2020.
4. India secured 168 rank in the 12th edition of the biennial Environment Performance Index (EPI Index 2020) — that measured the environmental performance of 180 countries. The country scored 27.6 out of 100 in the 2020 index, *available at*:https://www.downtoearth.org.in/news/wildlife-biodiversity/india-must-redouble-sustainability-efforts-environment-performance-index-71603 (last visited on Dec. 9, 2021).
5. Air Quality Worsens in Jammu, Srinagar, *available at:* tribuneindia.com/news/archive/j-k/air-quality-worsens-in-jammu-srinagar-747057 (last visited on December 27, 2021).

attainment cities across the country.††A report published in Lancet has revealed growing prevalence of COPD in J&K, which has pushed it among the top four states in India in terms of the respiratory disease. The researchers attributed respiratory disease in J&K to ambient air pollution and 'staggering' rate of smoking.‡‡ Talking specifically in context of Jammu City, the situation is particularly grim. A news titled 'Alarming high level of air pollution recorded in Jammu City' published in Kashmir Times revealed that the Jammuites suffered maximum respiratory diseases in 2016 to 2018 amongst all diseases. As many as thousands cases related to acute respiratory infection were registered during last three years.§§ A recent study released by the University of Chicago has found that residents in Jammu may be losing upto 4 years of their lives because of breathing polluted air.***Experts from J&K Pollution Control Board emphasize that 90 percent of air pollution in Jammu is vehicular.†††In Jammu district only, the total number of registered vehicles upto March 2017 were 6,69,136‡‡‡ and according to the 2011 Census, the total population of Jammu district has been recorded as 15,26,406. This means that the ratio of population to vehicles is approximately 3:1, and thus apparently this becomes one of the main reasons of air pollution in Jammu. Even under Revised Action Plan for Air Quality Management in Jammu City, the J&K Pollution Control Board revealed that about 60-70% of the overall pollution in Jammu City is contributed by pollution from vehicular emissions.§§§Since almost all the economic, social, government and cultural activities are concentrated in the City of Jammu., the City attracts large floating population from the whole region coming for education, medical facilities, business purposes, adding to the traffic and parking problems, and hence more vehicular exhausts.

The Air, We Breathe- Digging into Air Quality Data in Jammu City

While regulatory agencies and experts across J&K acknowledge air pollution as a deadly killer and its potential to wreak havoc and reel off statistics, it is critical to understand the numbers and what they really tell us. This enables one to communicate effectively about the state of the air we breathe, the scale of the problem or its key causes, the health and societal impacts, and what actions are needed to control it. Evidence-based communication, using data, is key to informing air quality interventions and saving lives.

On the basis of monitoring conducted under National Air Quality Monitoring Programme (NAMP) in Jammu City during 2011-15 and analysis of the data generated, the level of main air pollutant (RSPM/PM10) has been evaluated

6. Jammu, Srinagar cities' worsening air quality is nobody's concern, *available at:* https://www.dailyexcelsior.com/jammu-srinagar-cities-worsening-air-quality-is-nobodys-concern/ (last visited on December 27, 2021).
7. India State-Level Disease Burden Initiative CRD Collaborators. The burden of chronic respiratory diseases and their heterogeneity across the states of India: the Global burden of disease study 1990-2016, Lancet Global Health (2018).
8. Alarmingly high level of air pollution recorded in Jammu City, *available at:* https://www.kashmirtimes.com (last visited on September 9, 2021).
9. Air pollution lowering Jammu's Life Expectancy, *available at:* http://www.jammulinksnews.com/newsdetail/215283/Jammu-Links-News-Air_pollution_lowering_Jammus_Life_Expectancy (last visited on September 9, 2021).
10. Jammu – Down to Earth, *available at:*https://www.downtoearth.org.in/coverage/jammu-20608 (last visited on Jan 27, 2022).
11. Statistical Information of Motor Vehicles Department, Govt. of Jammu and Kashmir, *available at:* http://jaktrans.nic.in/statisticalinformation.htm (last visited on Dec. 27, 2021).
12. Revised Action Plan for Air Quality Management in Jammu City, *available at:* https://cpcb.nic.in/Actionplan/Jammu.pdf (last visited on Dec. 9, 2021).

towards higher side, violating the standard permissible limits consecutively for five years. Similar trend has been observed in air pollutants during last five years period 2013-14 to 2017-18. The data for last five years is as follows:****

Table 1

Monthly Average of Air Pollutants on 24-hours monitoring in Jammu City (2013-2014)

Monthly Average of Air Pollutants on 24-hourly monitoring at NAMP Sanctioned Locations in Jammu city during 2013-14.
(Month-Wise RSPM(PM10),SPM,NO2,SO2 level at NAMP locations)

Location:→ National Code:→		SPCB Complex Narwal Station Code-184 Area:- Residential(R)				M.A.M Stadium Station Code-482 Area:- Residential(R)				Bari Brahamana Ind. Area Station Code-507 Area:- Industrial(I)			
S.NO	Month	RSPM	SPM	NOX	SOX	RSPM	SPM	NOX	SOX	RSPM	SPM	NOX	SOX
1	April-2013	98.4	185	11.3	3.5	128	221	15.4	4.4	122	222	16.2	5.7
2	May	87	200	12.7	3.8	107	198	15.6	4.7	106	195	16.2	8.3
3	June	98	185	11.7	2.9	115	201	11.8	4.5	134	224	16.1	6.7
4	July	93	162	11.3	3.2	85	154	11.6	4.4	101	172	5.6	5.2
5	August	79	158	13.4	3.0	100	169	13.0	4.2	106	204	15	5.8
6	September	75	143	8.3	2.9	92	161	10.0	3.4	102	167	12.7	5.4
7	October	126	242	14.4	2.8	128	223	15.1	3.9	139	260	17.5	5.3
8	November	132	266	14.9	2.8	139	261	11.3	3.9	137	262	14.8	5.1
9	December	150	253	17.1	4.3	145	258	19.9	3.8	161	271	23.1	5.3
10	January-2014	165	268	17.9	3.5	174	283	20.8	3.4	172	281	21.7	6.9
11	February	121	238	13.95	3.0	140	272	18.3	4.0	153	278	17.6	7.8
12	March	136	225	13.0	3.5	131	234	14.65	3.6	134	231`	17.0	4.3
	Max	165	268	17.9	4.3	174	283	20.8	4.7	206	281	23.1	8.3
	Min.	75	143	8.3	2.8	85	154	10.0	3.4	101	167	5.6	5.1
	Average (Annual)	113	210	13.3	3.2	124	220	15.0	4.0	130	231	16.1	6.0

Standard limits:-

A- 24Hourly Avg.:- (i) RSPM=100µg/m³ (ii) SPM=200µg/m³ (iii) SO_2=80µg/m³ (iv) NO_2=80µg/m³

B- Annual Avg. :- (i) RSPM=60µg/m3 (iii) SO2=50µg/m3 (iv)NO2=40µg/m3

13. J&K Pollution Control Board: Home, *available at:* http://jkspcb.nic.in/Content/Amibient.aspx?id=223 (last visited on Dec. 18, 2021).

Table 2
Monthly Average of Air Pollutants on 24-hours monitoring in Jammu City (2014-2015)

Monthly Average of Air Pollutants on 24-hourly monitoring at NAMP Sanctioned Locations in Jammu city during 2014-15.
(Month-Wise RSPM(PM10),SPM,NO2,SO2 level at NAMP locations)

Location:→ National Code:→		SPCB Complex Narwal Station Code-184 Area:- Residential(R)				M.A.M Stadium Station Code-482 Area:- Residential(R)				Bari Brahamana Ind. Area Station Code-507 Area:- Industrial(I)			
S.NO	Month	RSPM	SPM	NOX	SOX	RSPM	SPM	NOX	SOX	RSPM	SPM	NOX	SOX
1	April-2014	123	203	12.6	2.9	119	205	13	3.2	133	218	12.6	4.4
2	May-2014	112	188	11.9	2.4	109	192	12.7	3.1	99	190	15.5	4.3
3	June	106	185	11.4	3.9	107	179	12.7	3.9	95	182	14.3	5.3
4	July	122	235	14.4	3	113	229	15	4	126	239	15.1	6
5	August	167	272	11.9	5	137	263	10	5	162	278	11.1	4.8
6	September	175	297	11.5	5.8	161	267	9.8	4.7	-	-	-	-
7	October	100	200	12.9	3	103	208	14.4	3.5	104	241	13	4.4
8	November	131	253	12.6	2.3	129	252	13.9	3	120	249	17	5.7
9	December	131	290	14.9	2.6	131	277	18.5	2.5	141	279	18.5	5
10	Jan-2015	144	267	17.9	2.5	144	271	18.8	3.2	144	255	20.1	4.5
11	February	156	270	17.1	2.8	153	276	23.4	3.3	149	274	20	4.4
12	March	121	191	20.5	3.1	116	185	18.5	3.5	109	213	21.6	4.7
	Max	175	297	20.5	5.8	161	277	23.4	5	162	279	21.6	6
	Min.	100	185	11.4	2.3	103	163	9.8	2.5	95	182	11.1	4.4
	Average (Annual)	**132**	**238**	**14**	**3.2**	**127**	**234**	**15**	**3.5**	**126**	**238**	**16**	**4.8**

Table 3
Monthly Average of Air Pollutants on 24-hours monitoring in Jammu City (2015-2016)

Monthly Average of Air Pollutants on 24-hourly monitoring at NAMP Sanctioned Locations in Jammu city during 2015-16.
(Month-Wise RSPM(PM10)SPM,NO2,SO2 level at NAMP locations)

Location:→ National Code:→		SPCB Complex Narwal (R) Station Code-184				M.A.M Stadium (R) Station Code-482				Bari Brahamana Ind. Area (I) Station Code-507			
S.No	Month	RSPM	SPM	NOX	SOX	RSPM	SPM	NOX	SOX	RSPM	SPM	NOX	SOX
1	April-2015	105	192	17.9	3.4	105	194	18.9	3.7	109	191	16.8	6.7
2	May	109	209	11	3.2	120	191	15.3	3.1	114	200	18.6	5.6
3	June	125	225	14.3	3	115	217	16.3	3.4	117	221	17.3	4.3
4	July	113	193	12.7	3.4	119	203	13.3	3.2	111	197	15.5	3.9
5	August	124	215	15.1	2.4	116	221	13.9	2.9	127	220	16.8	3.7
6	September	132	225	14.9	2.4	140	219	16.7	3	139	229	17.6	4.1
7	October	145	247	13.7	2	131	251	16.9	2.9	144	251	16.7	3.7
8	November	108	199	16.1	5	110	203	15.2	3.7	117	213	16.8	3.1
9	December	124	232	15.8	2.3	115	203	15	2.5	126	240	16.6	3.16
10	Jan.2016	140	250	16.6	2.5	143	257	16.9	2.8	144	256	17.1	3.6
11	February	137	239	16.5	2.9	128	243	16.2	2.6	137	239	16.1	3.1
12	March	111	189	16.4	4	116	207	16.3	3.4	119	211	15.8	5
	Max	145	250	17.9	5	143	257	18.9	3.7	144	256	18.6	6.7
	Min.	105	189	11	2	105	191	13.3	2.5	109	191	15.5	3.1
	Average (Annual)	**123**	**218**	**15**	**3**	**122**	**217**	**15.9**	**3.1**	**125**	**222**	**16.8**	**4.2**

Table 4
Monthly Average of Air Pollutants on 24-hours monitoring in Jammu City (2016-2017)

Monthly Average of Air Pollutants on 24-hourly monitoring at NAMP Sanctioned Locations in Jammu city during 2016-17.
(Month-Wise RSPM(PM10),SPM,NO2,SO2 level at NAMP locations)

Monitoring Location:→ NAMP Station Code: →		SPCB Office Complex,Narwal Station Code-184 Area:- Residential(R)				M.A.M Stadium, Jewel Chowk Station Code-482 Area:- Residential(R)				Bari Brahaman Industrial Area Station Code-507 Area:- Industrial(I)			
S.No	Month	RSPM	SPM	NOX	SOX	RSPM	SPM	NOX	SOX	RSPM	SPM	NOX	SOX
1	April-2016	121	198	13.9	2.6	109	208	13.6	2.6	112	180	15.3	2.8
2	May	108	189	15.9	2.5	114	198	15.3	2.8	110	193	15	2.7
3	June	126	237	16.2	2.7	132	233	12.9	2.6	129	250	13.9	3.1
4	July	100	195	14.2	3	100	193	16	3	104	195	18.4	4.4
5	August	119	240	16	4.3	118	198	18.1	4.7	126	222	17.9	5.3
6	September	135	282	17.2	3.3	135	261	14.3	3.8	131	267	20.3	3.7
7	October	134	253	16.8	3.4	137	251	15.6	4.4	132	244	17.4	4.8
8	November	165	303	19.7	3.3	167	303	20.1	3.7	165	299	21.2	5.3
9	December	159	309	21.6	3.2	149	287	19.2	3.2	150	300	21.3	4.5
10	Jan.2017	159	281	19.8	3.5	130	228	18	3.3	133	262	19.3	3.9
11	February	176	301	22.8	3.7	166	288	22.3	3.7	172	285	22.2	3.9
12	March	141	269	17.1	3.4	141	278	15.8	4.5	164	266	19	3.6
	Max	176	309	22.8	4.3	167	303	22.3	4.7	172	300	22.2	5.3
	Min.	100	189	13.9	2.5	100	193	12.9	2.6	104	180	13.9	2.7
	Average (Annual)	137	255	17.6	3.24	133	244	16.76	3.5	136	247	18.4	4

Table 5
Monthly Average of Air Pollutants on 24-hours monitoring in Jammu City (2013-2014)

Monthly Average of Air Pollutants on 24-hourly monitoring at NAMP Sanctioned Locations in Jammu city during 2017-18.
(Month-Wise RSPM/PM10,PM2.5,NO2,SO2 level at NAMP locations)

Monitoring Location:→ NAMP Station Code: →		SPCB Office Complex,Narwal Station Code-184 Area:- Residential(R)				M.A.M Stadium, Jewel Chowk Station Code-482 Area:- Residential(R)				Bari Brahaman Industrial Area Station Code-507 Area:- Industrial(I)			
S.No.	Month	PM10	PM2.5	NOX	SOX	PM10	PM2.5	NOX	SOX	PM10	PM2.5	NOX	SOX
1.	April-2017	154	N/D	17.54	4.55	159	N/D	18.66	4.37	175	N/D	32.25	4.44
2.	May-2017	156	N/D	19.29	4.41	137	N/D	13.54	3.67	153	N/D	18.17	4.14
3.	June-2017	130	N/D	17.4	3.23	124	N/D	17.69	3.5	131	N/D	19.75	4.0
4.	July-2017	121	N/D	13.34	2.77	116	N/D	14.58	2.67	125	N/D	14.84	3.46
5.	August-2017	128	29.05	16.55	3.31	125	63.53	15.11	3.61	139	20	15.92	3.33
6.	September-17	141	46.55	17.77	3.98	146	36.04	18.34	4.18	136	43.89	18.33	3.56
7.	October-2017	138	51.82	17.5	4.06	145	56.14	11.45	3.48	138	45.3	17.34	4.33
8.	November-2017	169	62.8	19.8	4.4	181	75.0	19.2	4.7	166	62.2	18.6	4.2
9.	December-2017	180	48.5	19.63	3.55	193	43.99	19.9	4.2	177	47.99	19.6	3.74
10	January-2018	170	45.8	19.37	4.08	177	44.37	17.88	3,85	171	47.96	19.2	4.1
11	February-2018	180	46.7	19.36	4.17	199	39.53	19.76	4.16	192	45.49	19.8	5.8
12	March-2018	193	49.9	17.08	4.57	192	49.8	18.64	4.25	187	49.19	21.0	5.42
Average during the Year (April 2017-March-2018/Std		155 (60 µg/m³)	47.64 (40µg/m³)	17.88 (40µg/m³)	3.92 (50µg/m³)	158 (60µg/m³)	51.5 (40µg/m³)	17.06 (40µg/m³)	3.88 (50µg/m³)	157.5 (60µg/m³)	43.0 (40µg/m³)	19.57 (40µg/m³)	4.21 (50µg/m³)

Further, the monthly variation of particulate matter (RSPM/PM10) level at three NAMP monitoring locations in Jammu city, evaluated in last two years is given graphically as:

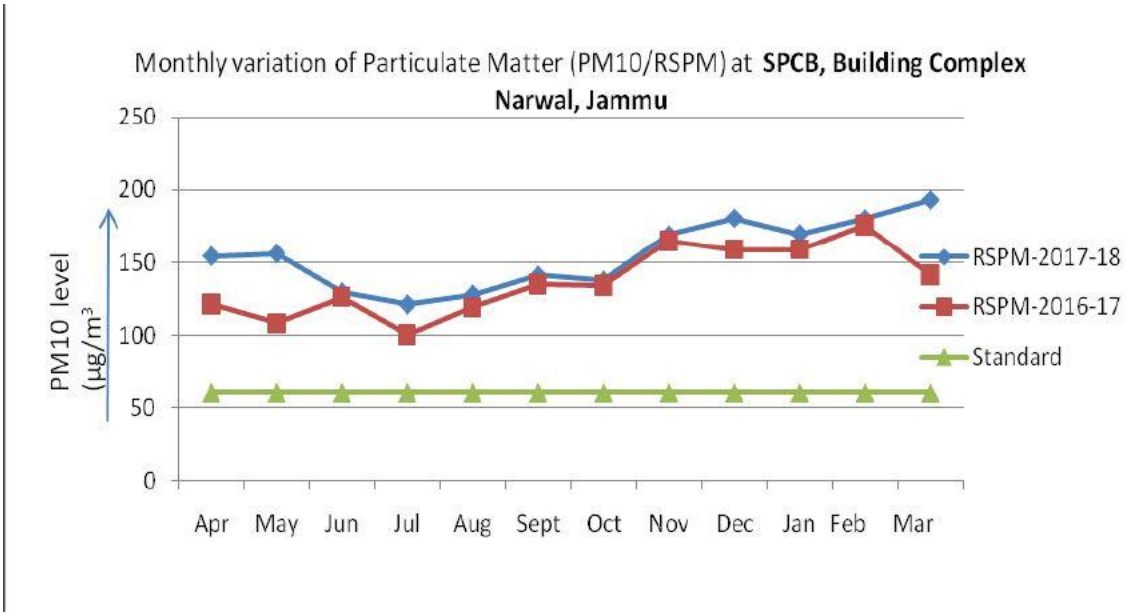


Fig. 1: Monthly variation of Particulate Matter (RSPM/PM10) level at SPCB building Complex, Narwal

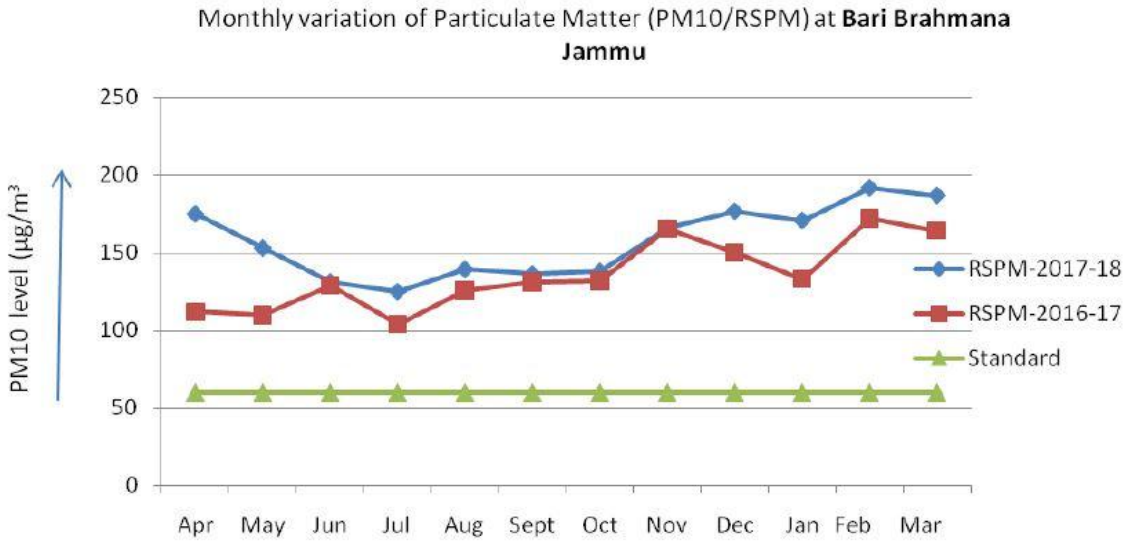


Fig.2: Monthly variation of Particulate Matter (RSPM/PM10) level at Bari Brahmana, Jammu

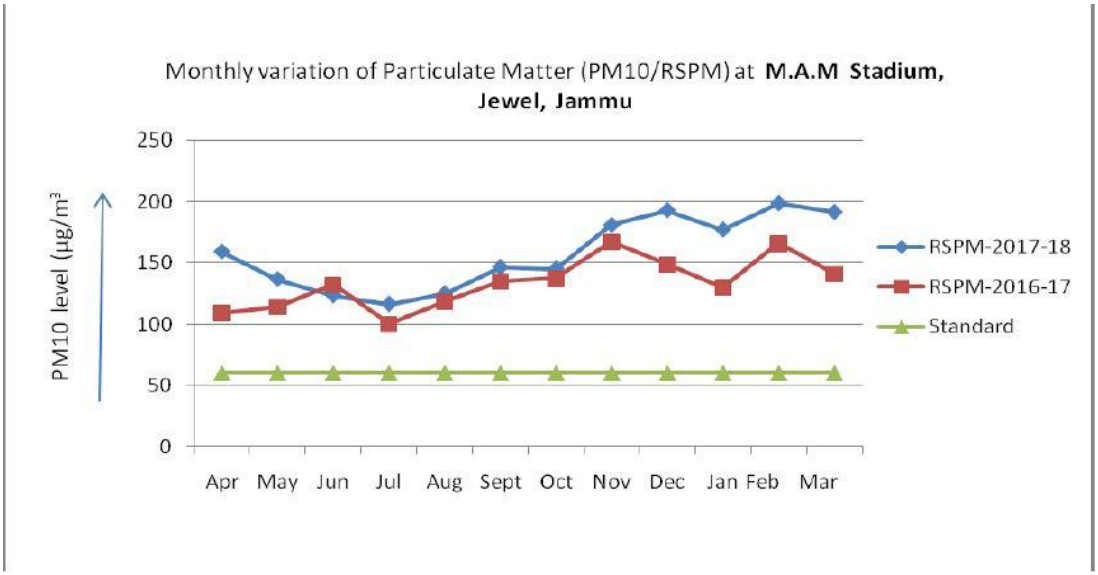


Fig. 3: Monthly variation of Particulate Matter (RSPM/PM10) level at M.A.M. Stadium, Jewel, Jammu

The annual average (inµg/m³) of Air Pollutants in Jammu City during the year 2013 to 2017 reveals that the level of RSPM (PM10) and PM 2.5 concentration exceeded the standard limits.

Table 6
Annual Average (in µg/m³) of Air Pollutants in Jammu City (2013 to 2017)

S.No.	Year	RSPM/PM_{10} Annual Average (µg/m³)	$PM_{2.5}$ Annual Average (µg/m³)	SO_2 Annual Average (µg/m³)	NO_2 Annual Average (µg/m³)
1.	2013-14	122	-	4.4	14.8
2.	2014-15	128	-	3.8	15.0
3.	2015-16	123	-	3.4	16.0
4.	2016-17	135	-	3.6	17.6
5.	2017-18	156	47.3	4.0	18.17

Months with high air pollution levels in Jammu city from 2013 to 2018 is as follows:

Table 7
Months with high pollution in Jammu City (2013-2018)
Months with high Air Pollution levels in Jammu city during the period 2013-14 to 2017-18.

S.No.	Year	Month with high Air Pollution level during the year	Remarks
1.	2013-14	October-January	-RSPM (PM10) Level exceeded the standard limits during the period. -SO2/NO2 Level ranges with in standard limits.
2.	2014-15	September-February	
3.	2015-16	September- February	
4.	2016-17	September- February	
5	2017-18	September- February	

Table 8
Monthly average of air pollutants in Jammu City (2019-20)

MONTHLY AVERAGE OF AIR POLLUTANTS IN JAMMU CITY DURING 2019-20

Location:→ National Code:→		SPCB Complex Narwal (R) Station Code-184				M.A.M Stadium (R) Station Code-482				Bari Brahamana Ind. Area (I) Station Code-507			
S.NO	Month	RSPM	PM2.5	NOX	SOX	RSPM	PM2.5	NOX	SOX	RSPM	PM2.5	NOX	SOX
1	Apr-19	146	45.7	14.23	2.9	137	38.3	16.64	3.1	136	42.36	13.23	2.64
2	May	157	52.62	11.96	4.51	152	49	12.34	3.85	162	41.23	13.18	3.54
3	June	147	26..0	21.9	3.62	160	40	21.33	4.1	164	37.31	22.1	3.47
4	July	127	25.16	12.82	2.54	136	26.49	15.4	3.25	135	28.3	15.74	3.15
5	August	115	21	12.32	2.82	119.2	23.4	14.8	3	121	25.8	14.7	2.7
6	September	135	28.1	18.55	3.2	132	23	18.7	3	131	31.2	19.4	3.25
7	October	125	30.52	17.51	2.92	127	29.77	17.94	3	128	29.17	17.13	3.01
8	November	151	30.55	19.2	3.5	146.5	30.7	18	2.9	156	39	20.1	3.2
9	December	158	38.09	19.83	2.84	154	42.5	19.93	2.62	159	37.29	20.5	2.91

Unplanned urbanization and excessive motorization have worsened the quality of air we breathe. The air quality indices in City of Jammu and Srinagar are alarming to such an extent that it has pushed these cities in the category of non-attainment cities.

Vehicular Pollution in Jammu City

We can observe the conversion of Jammu City into a concrete jungle teeming with buildings, vehicles and unplanned urbanization. The preceding discussion

succinctly reveals the trends in population growth in the last few decades, and the equal rise in population of vehicles. Most importantly, the suspended particulate matter and respiratory particulate matter have witnessed a steep rise in Jammu city in the past two decades mainly because of the increase in the number of vehicles. The pollution from vehicles is due to discharge like CO, unburnt HC, Pb, NO2 and SO2 and SPM mainly from tailpipes††††Numerous studies conducted in the city of Jammu amply demonstrate the deteriorating air quality standards due to rise in vehicular exhausts.

A study conducted by the State Pollution Control Board, Jammu to monitor the ambient air quality across eleven traffic intersections in the Jammu City in December 1997 revealed that the lowest level was 370 g/cum and the highest was 1,635 g/cum (See graph: Jammu's heavy air). Of the 11 sites where monitoring was conducted, six recorded levels well above the 1,000 g/cum mark.

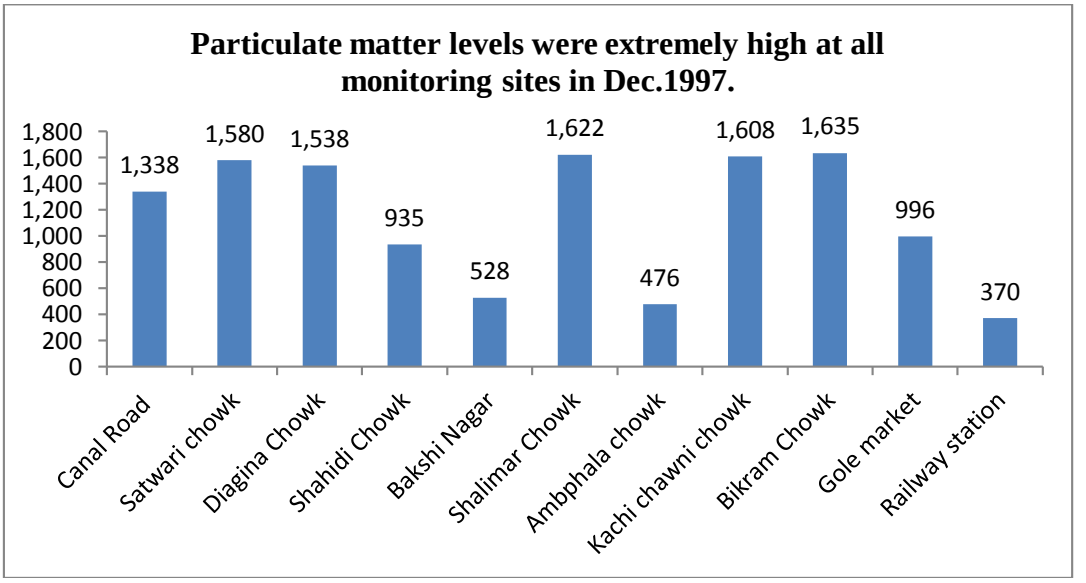


Fig. 4: Jammu's Heavy Air

X- Site of monitoring in Jammu City
Y- List of Suspended Particulate Matter in Ambient Air (in microgrammes per cubic meters)
(Source: Anon 1998, Vehicular Pollution, in Survival Quarterly Newsletter of the J&K State Pollution Control Board, Jammu)

Barneet Kour and Anil K. Raina(2017)‡‡‡‡ in a study on "Ambient air quality status of Jammu City" has indicated vehicular pollution to be a major contributor for deterioration of air quality. It has been highlighted by collecting data for air quality parameters viz., Sulphur dioxide, Nitrogen dioxide, Respirable suspended particulate matter from two heavy traffic area and one low traffic area. The data

14. R.K. Shrivastava, Neeta Saxena, *et.al.*, "Air Pollution due to Road Transportation in India: A Review on Assessment and Reduction Strategies" 8 *Journal of Environmental Research and Development* 69-79 (2013).
15. BarneetKour and Anil K. Raina, "Ambient Air Quality Status of Jammu City" 18 *Environment Conservation Journal* (2017).

on studied parameters has been collected for two heavy traffic areas viz., Satwari-Bikram Chowk Road (Site-I) and Kunjwani-Narwal Byepass (Site-II) and compared with a reference location with low traffic area viz., University of Jammu Campus (Site-III), for a period of two years i.e., December 2013-November 2015. Results revealed that Sites-I and Sites-II recorded higher concentration of all the studied pollutants than Site-III. Further, air quality indices computed from the selected data revealed Sites-I and II to have moderate to severe air quality status whereas light to moderate air quality status have been recorded for Site-III.

Sharma and Raina (2012)[§§§§]monitored the ambient air quality (with respect to SO_2 and NO_2) of Jammu City, for the year 2004 and 2005 at selected locations of 3 residential areas, 3 commercial areas and 3 traffic crossings. Their study revealed significant increase in the concentration of $SO_2$and NO_2 in the year 2005 as compared to the year 2004, though these have been observed to be within the permissible limits of CPCB except for a traffic crossing (Vikram Chowk) in both the years. Seasonally, SO_2 exhibited its low value during post-monsoon period except for a commercial site (Gole Market) and traffic crossing (Rehari Chowk). Similarly, NO_2 also exhibited low values during post-monsoon period except for Karan Nagar (Residential Area), Gole Market (Commercial Area) and Satwari Chowk (Traffic Crossing).

Bakshi investigated roadside air quality of Jammu city and reported higher levels of suspended particulate matter (SPM) owing to heavy automobile traffic.[*****]
Similarly, on the basis of experiment conducted on *Duranta repens* (plant) at major traffic crossings within the Jammu City and also inside the Jammu University Campus, which has been taken as a reference site, the air pollution tolerance index has been calculated and found to increase significantly in plants kept at these traffic crossings. The study indicated that the *Duranta repens* serve as sink to air pollutants, and can be effectively employed for phyto-monitoring auto exhaust pollution along road side of the busy traffic ways.[†††††]

In an analysis performed to evaluate the impact of weekend lockdown on air quality parameter in Jammu district,[‡‡‡‡‡] the results stated that PM 2.5 and PM 10 consistently dropped by -11.71% and -12/18% during weekend restriction as compared to weekdays. NO_2 and O_3 also projected significant deviations in atmosphere by -8.73% and -17.01% ultimately imparting change in air quality index by -15.09%. Pertinent to note that the weekend lockdown enforces restrictions and self-quarantine measures in Jammu district, which helps in reducing emission from transportation and industries.
According to IQ Air, an environment literacy foundation, the PM2.5 concentration in Jammu city is currently much above the WHO annual air quality guideline value. However, the air quality index forecast for the coming month especially

16. A. Sharma and A.K. Raina, "Ambient Air Quality of Jammu City: A Study with reference to SO2 and NO2 Contents" 3 (1) *International Journal of Environmental Science* (2012).
17. N. Bakshi, *Study on Road Side Air Quality of Jammu City. Master's Thesis*, Submitted in Department of Environmental Sciences, Jammu University, Jammu, India, 2001.
18. Anil K. Raina and Chand Bala, "Effect of vehicular pollution on *Duranta repens L.* in Jammu City" 3 *Journal of Applied and Natural Science* 211-218 (2011).
19. Vihaw Vikas, Jag Paul Sharma, *et.al.,* "Air Quality Changes during Weekend Lockdown amid Coronavirus (COVID-19) Pandemic: Case Study of Jammu District (J&K), India" 9 *Chemical Science Review and Letters* 1020-1025 (2020).

18th to 21st April succinctly describes the 5-7 times higher concentration of PM2.5 in Jammu city, much above the WHO annual air quality guideline value.§§§§§

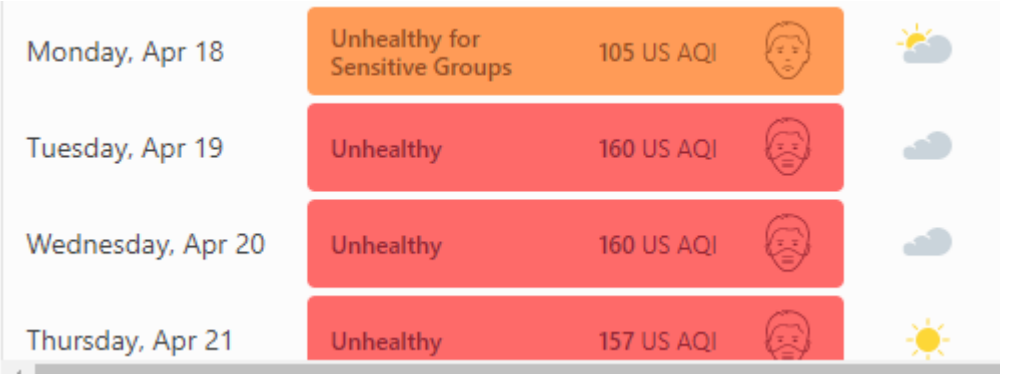


Fig. 5: AQI Forecast for Jammu City (April month)
(Source: https://www.iqair.com/in-en/india/jammu-and-kashmir/jammu)

Factors affecting vehicular pollution in Jammu City

Among the major factors affecting vehicular pollution/emission, vehicle population, traffic congestions, type and quality of fuel and efficiency of the vehicles turns out to be the main culprit in the City of Jammu.

Vehicle population growth:

The vehicular pollution assumes special significance in Jammu city and its surroundings primarily due to two reasons: firstly, constant increase in level of air pollutants resulting in its categorisation under 'non-attainment' city and secondly, a rapid increase in the fleet of vehicles moves in and around the city. The registered vehicles in Jammu have increased significantly over the years. The numbers of vehicle registration per year have almost doubled from 0.34 Lakh to 0.59 Lakh in the last nine years. This high density and rapid growth of vehicles have worsened the transport situation to a significant extent. The registered vehicle from year 2010-2018 is presented in Figure 6.

20. Jammu Air Quality Index (AQI) and India Air Pollution| IQAir, *available at:* https://www.iqair.com/in-en/india/jammu-and-kashmir/jammu (last visited on March 2, 2022).

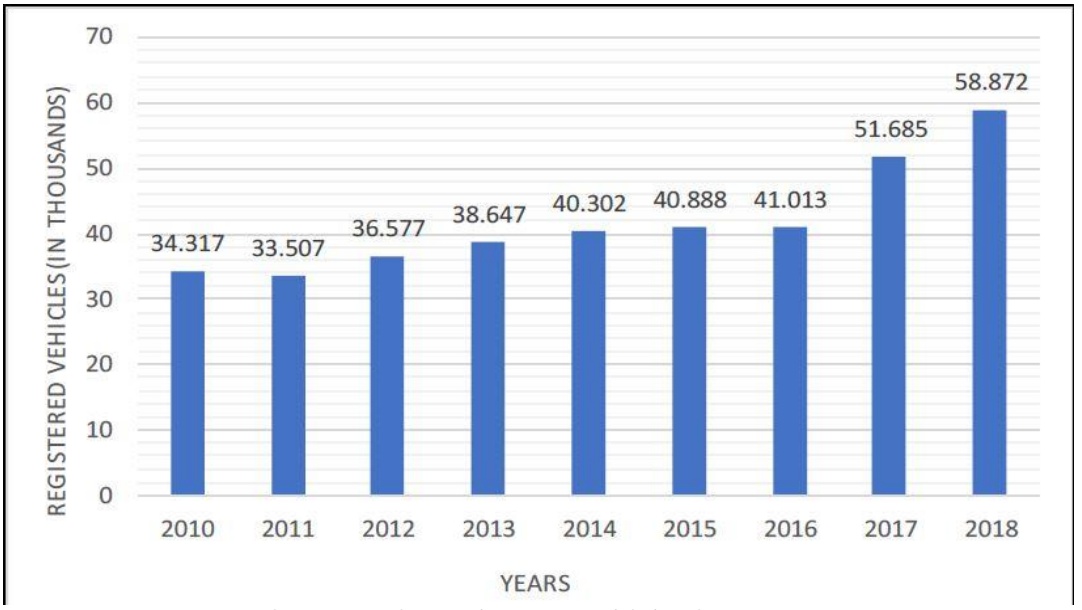


Fig. 6: Registered Motor Vehicles in Jammu
(Source: Jammu RTO Office, 2018 Statistics)

The study by the Centre for Science and Environment titled 'At the Crossroads' has highlighted that if cars and two-wheelers are combined, the personal motorization rate in India would exceed that of many advanced countries. Automobile dependence will worsen exposure to toxic vehicular pollution. It further exacerbates the situation due to lack of adequate public transport facilities in cities and little attention paid towards walkable and cycling environments, the report added.[******] Unfortunately, during the survey conducted by researcher amongst 450 respondents from commercial, residential and traffic intersections, majority of the respondents revealed that they preferred to commute either in their personal vehicles or auto-rickshaws, and very few opted for public transport facilities, walking or cycling as a preferred option to move in their daily routine.

Moreover, based on land use distribution data in Year 2011, only 2.9 per cent of the land is under circulation which highlights the deficiency of road network. This aspect has been tried to manage under the land-use plan as per Master Plan 2031 where Transport continues to occupy a significant share of the land in the city. However, it has yet to be seen that whether the proposed plan will be completed within fixed timeframe. The land-use plan as per Master Plan 2032 is shown in Table 9.

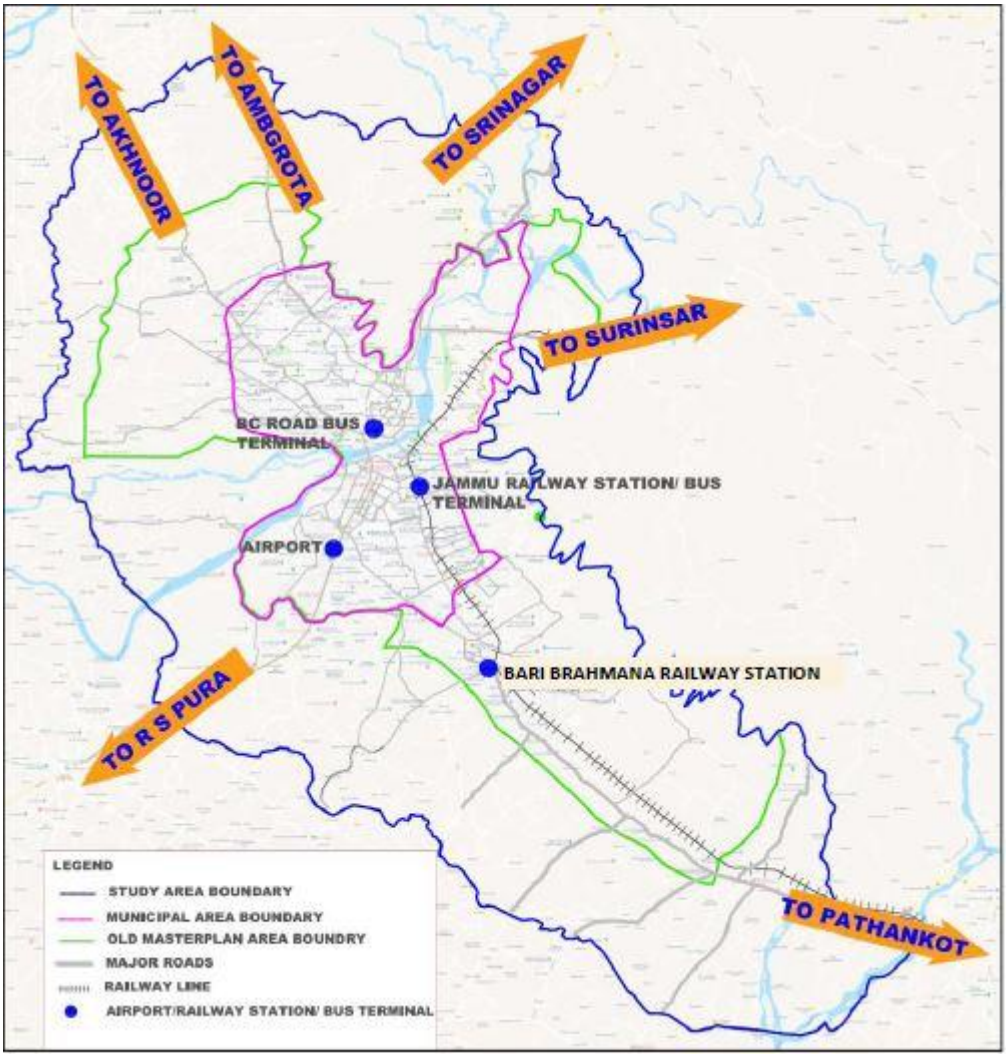
21. AnumitaRoychowdhury, Vivek Chatopadhaya, *et.al.*, *5 June: At the Crossroads*, Centre for Science and Environment (2019).

Table 9
Comparison of Landuse Distribution in Years 2011 & 2032

S. No.	Landuse	Landuse - 2011		Proposed Landuse - 2032		% Change
		Area (in Sq Km)	Percentage	Area (in Sq Km)	Percentage	
1	Residential	57.6	8.8	164.9	25.3	65
2	Commercial	25.2	3.9	35.4	5.4	29
3	Industrial	6.0	0.9	11.9	1.8	49.2
4	Public & Semi-Public	18.6	2.9	43.3	6.6	57
5	Recreation	32.5	5.0	33.3	5.1	2.5
6	Traffic & Transport	19.1	2.9	38.2	5.9	50.1
7	Water body	40.4	6.2	40.4	6.0	0
8	Agriculture	383.2	58.7	213.0	32.9	-79.9
9	forest	44.3	6.8	43.8	6.7	-1.1
10	Defence	25.4	3.9	28.1	4.3	9.4
	Total	**652.3**	**100**	**652.3**	**100**	

(Source: Jammu Master Plan, 2032)

The existing road network of Jammu is basically of radial pattern. Five roads namely Srinagar Road, Pathankot Road, Akhnoor Road, R.S. Pura Road and Ambgrota Road (Bantalab Road), are converging to the city from different directions.



(Source: https://jkpwdrb.nic.in/pdfs/Jammu_CMP.pdf)

Jammu is the northern most major railway head and is well connected to all State Capitals of India by rail. It is also well connected to major cities like Srinagar, Delhi, Leh, Mumbai, Lucknow, Chandigarh, Gwalior etc. by air services. Due to its locational advantage, Jammu assumes importance on the linkage corridor to Salal Project, Rajouri, Poonch, Kishtwar, Doda, Akhnoor, Katra, Kathua and Udhampur serves as the gateway to Kashmir valley.

The public transport services are rather scattered and presently Matador is the only mode of public transport in Jammu. It is highly inadequate to deal with about 12 lakh passenger trips daily which are expected to grow to almost 29 lakh passenger trips daily by 2021. Besides this, about 8000 intra-city goods vehicle trips are generated daily at present which will grow to about 31000 daily trips by

2021.†††††† Private auto, shared taxis/tata sumo and maxi cab are supplement to these transportation services. The population of surrounding towns of Jammu is also expected to grow rapidly due to its close proximity to Jammu. This will result in higher traffic interaction between the city and these towns due to rise in vehicular population and shortage of existing road network.

Traffic Congestion

Traffic congestion increases vehicle emissions and degrade ambient air quality, and recent studies have shown excess morbidity and mortality for drivers, shopkeepers at traffic intersections, commuters and people living near major roadways. A new research indicated that not just air pollution, but sitting in vehicles due to traffic congestion are also contributing to the increase in the number of lung cancer cases.‡‡‡‡‡‡ Unfortunately, while regulating of ever increasing volume of traffic, nothing tangible has been done to address the traffic management in the Jammu city. The traffic chaos is neither going to be over by providing multi-level parking facilities in the city nor by lifting of and towing away a few wrongly parked vehicles on the roads or any other similar measure which can best be termed as cosmetic, patchwork and variegated approach . While a vehicle, whether four-wheeler or two-wheeler should in principle have proper parking facilities at suitable locations, the same is nowhere seen available while the owners usually park them at their will and even at those points which create hurdles in the smooth traffic movement. This increase in traffic congestion results in decrement of the average speed of all vehicles below the eco-friendly speed leading to the rise in rate of emission per kilometre.§§§§§§The worst problem of traffic chaos is faced by people on Canal Road up to Jewel, Talab Tillo- Bohri road, Raghunath Market, Roopnagar, Janipur -Newplot road, Bantalab road interior city roads from New Plot to Kachi Chawni and Parade. With number of malls, showrooms, V Marts etc opening on roadside, the rush of consumers visiting there is also increasing day by day. One can observe the traffic congestion and inconvenience faced by people on Apsara Road. Due to lack of proper parking space in front of these business houses, the customers park their vehicles on roadside which totally hampers smooth movement of traffic on the city roads putting the people as well as commuters to a lot of inconvenience and trouble. The police as well as Traffic Police manning these roads also hardly bother to intervene and act against drivers who park their vehicles on the roadside or even centre of the road.*******

Further, the traffic signals in Jammu city uses predefined hardware, which function according to the signal plans stored in that hardware and does not change in real time depending on the current traffic situation. Due to the fixed signal plans, it increases the waiting time, fuel consumption, and pollution. Thus it is important to install a system which will monitor real time traffic and generate the signal plans according to the current traffic situation. A combination of traffic

22. Comprehensive Mobility Plan for Jammu, *available at:* https://jkpwdrb.nic.in/pdfs/Jammu_CMP.pdf (last visited on Jan 27, 2022).
23. Not just air pollution, sitting in traffic jams could cause lung cancer, *available at:* https://indianexpress.com/article/lifestyle/health (last visited on March 19, 2022).
24. Vinish Kathuria, *Vehicular Pollution Control- Concept Note* 3-9 (Madras School of Economics, Chennai, 2014).
25. Avtar Bhat, "No end to traffic chaos in Jammu City, Authorities helpless", Daily Excelsior, Feb. 28, 2002.

engineering measures, demand management measures, and measures giving priority to public transport and non-motorised transport infrastructure has been shown to be the best approach, especially in the study area, where vehicular population and pollution has increased manifold in the last decade**.**

Quality and Type of Fuel:

Quality and type of fuel also has a direct bearing on the nature of vehicular emissions. Diesel and petrol driven vehicles are known to cause more pollution than CNG/LPG powered vehicles. Changeover to hydrogen as fuel can completely avoid pollution from engines and efforts in this direction are constantly being made.[†††††††] Regrettably, the issue of CNG availability across different regions of J&K and high purchasing cost has made their preference very low amongst buyers. Even those who already owns a vehicle hardly wants to fit CNG-kit due to space, safety and high cost of installation. No doubt changeover to less polluting fuel after making necessary modification in the vehicle is allowed but it should be seen that what policy changes, whether in the form of incentives or subsidies, are required to makes these options fully exercisable. Similarly, quality of fuel is associated with the efficiency of vehicles, and hence emissions. Fuel adulteration increases the emission of total hydrocarbons, carbon monoxide, nitrogen oxides and particulate matter and thus adds to air pollution. According to the experts, the impure fuel is turning the cities into gas chambers, reducing efficiency, weakening national productivity and dragging the economy down. In a written reply of an un-starred question of the Lok Sabha on July 27, 2015, regarding adulteration of petrol and diesel, the Union Government had stated that total 21 cases of adulteration and under-measurement were found in J&K in the last three years.[‡‡‡‡‡‡‡] Fuels like petrol and diesel are often adulterated with fuels like kerosene because kerosene is substantially cheaper than diesel and petrol due to high subsidies granted by the government. Trucks, buses, tractors and tempos are the frequent user of kerosene which not only harms their vehicles but also worsens urban air pollution. Even during pilot research for current study, the researcher observed the practice of modifying diesel/petrol engines in Transport Nagar, Jammu by vehicle owner so that they can use kerosene as a substituted fuel. Shockingly, such activities are running under the noose of regulatory and enforcement agencies. It seems that the regulatory agencies have learnt nothing from the situation in Delhi and waiting for the Jammu City to reach that stage of pollution. so regular inspection of petrol pumps is must and those found involved in adulteration need to be penalized strictly.

Old and inefficient Vehicles:

Even there is large contribution of air pollution in Jammu City from old and inefficient vehicles. Pertinently, the authorities at J&K Pollution Control Board attribute the deteriorating air quality to the increasing number of vehicles along with the presence of a number of old vehicles.[§§§§§§§]Vehicles after particular age are considered to pollute the environment with greater pace than newer

26. Rajni Kant and Keshav Kant, *Air Pollution and Control* 256-259 (Khanna Book Publishing Co. Ltd., New Delhi, 2018).
27. Amit Khajuria, "Adulterated fuel adds to Jammu's pollution, authorities unconcerned", *The Tribune*, Dec. 17, 2015.
28. Farzana Syed, "Increasing Vehicles major contributors to Pollution", *Kashmir Times*, March 23, 2018.

vehicles. The current policy of restricting and phasing out of old vehicles in J&K is in consonance with this principle. Even recently the Central Government also announced the Vehicle Scrappage Policy to undo the effects of high emissions released by older vehicles. ********The Government of J&K has also proposed to phase out 500 diesel driven commercial vehicles of 15 to 25 years age for which a budget of Rs. 25 crores has also been approved for financial assistance in the form of a soft loan of Rs. 5 lac to each transporter. State Transport Authority has also issued circular banning re-registration of BS-III vehicles, under the pollution emission norms, which are being purchases from outside J&K and re-registered in the State, with immediate effects. ††††††††

The process of phasing out of older vehicles and successful implementation of vehicle scrappage policy is highly required in Jammu district since as per category-wise vehicles registered upto March 2018 in Jammu district, 21, 019 vehicles aged between 15-25 years, albeit the commercial vehicles constituting the largest share.‡‡‡‡‡‡‡‡ Even proactive efforts by concerned agencies are required to establish automated testing station and scrapping facilities at least in twin capital cities of J&K so that the process shall not be delayed like other air quality management interventions carried in the past.

Public Health and Vehicular Pollution

Going by the estimates that 90% of the World's population breathe harmful air, it can be easily discernible that a significant population of the world live in areas that do not meet the air quality standards. Though difficult to believe but India dominates the list of world's most polluted cities. On average its cities exceed World Health Organization (WHO) guidelines for particulate pollution (PM2.5) in the atmosphere by 500%, according to the recent World Air Quality Report.§§§§§§§§ The most dangerous aspect of vehicular pollution is that the pollutants are released and remain at a level at which we breathe in the air, thereby posing far more danger to human health than via chimney. The major pollutants released by the burning of fuels in the vehicles and their consequential effects on human health are as follows:*********

Ozone

Formed due to chemical reaction between nitrogen oxides and hydrocarbons in sunlight, which are released due to automobile fuel combustion. Though beneficial in the upper atmosphere, at the ground level ozone can irritate the respiratory system, causing coughing, choking, and reduced lung capacity.

29. PM Modi launches vehicle scrappage policy-India Today, *available at:* https://www.indiatoday.in/auto/story/vehicles-scrappage-policy-launched-all-rules-and-benefits-explained (last visited on Dec. 27, 2021).
30. *Supra* note 12.
31. *Ibid.*
32. India dominates the list of the world's most polluted cities, *available at:* https://www.weforum.org/agenda/2020/0308-of-the-worlds-10-most-polluted-cities-are-in-india (last visited on Dec.9, 2021),
33. Cars, Trucks, Buses and Air Pollution, *available at:* https://www.ucsusa.org/resources/cars-trucks-buses-and-air-pollution; Se also, Vehicular Pollution-ENVIS NIOH, *available at:* http://niohenvis.nic.in/newsletters/vol11_no4_Vehicular_pollution.pdf (last visited on Dec.9, 2021).

- *Particulate matter:* These particles of soot, metals, and pollen give smog its murky color. Amongst vehicular pollution, fine particles pose the most serious threat to human health by penetrating deep into lungs.
- *Nitrogen oxides:* In an automobile engine, when fossil fuel combusts at high temperatures, dinitrogen and dioxygen combine to yield significant quantities of nitric oxide and nitrogen dioxide. These vehicular pollutants can cause lung irritation and weaken the body's defenses against respiratory infections such as pneumonia and influenza. In addition, they assist in the formation of ozone and particulate matter.
- *Carbon monoxide:* This odorless, colorless gas is formed by the combustion of fossil fuels such as gasoline. Cars and trucks are the source of nearly two-thirds of this pollutant. When inhaled, CO blocks the transport of oxygen to the brain, heart, and other vital organs in the human body. It binds to hemoglobin to form carboxyhemoglobin, and when its concentration reaches about 3-4%, the oxygen-carrying capacity of the blood reduces. Newborn children and people with chronic illnesses are especially susceptible to the effects of CO.
- *Sulfur dioxide:* Motor vehicles create this pollutant by burning sulfur-containing fuels, especially diesel. The pollutant sulphur dioxide is a gas that is poisonous to both animals and plants. It's low concentration causes respiratory diseases, for example, asthma, bronchitis, and emphysema in human beings.
- *Lead:* Automobile emission is the predominant source of lead pollution. It impairs liver and kidney, causes brain damage in children resulting in lower I.Q., hyperactivity and reduced ability to concentrate.
- *Benzene:* The biggest source of benzene in the air is vehicular exhaust and fuel vapours. According to experts, while some benzene is produced when fuel is burnt, the major part is contributed as vapour from petrol pumps. The pollutant is highly toxic even at low concentrations and is known to cause leukemia in the long run, which is a malignant progressive disease in which the bone marrow and other blood-forming organs produce increased numbers of immature or abnormal leucocytes.[34]

Most importantly, when left unchecked, these health conditions can cause death. A recent study by the International Council of Clean Transportation has succinctly exposed the lethal effects of vehicular fumes across major vehicle markets of the word. It is worrying that the exhausts from on-road diesel vehicle is responsible for nearly half of the impacts-181000 premature deaths worldwide, and two-thirds in India, France, Germany, and Italy. Amongst the 100 major urban centres assessed for transport sector-related deaths globally, New Delhi ranks sixth. The study is indicative of the fact that how the transport sector health burden is linked with vehicles' contribution to elevated levels of particulate matter nitrogen oxides and ozone. This has exposed the widely damaging impacts of vehicles that include tailpipe emissions, evaporative emissions, resuspension of road dust, and particles from brake and tyre wear. Among the four transportation subsectors analyzed during the study, on-road diesel vehicles have been found to

34. Air Pollution in Delhi: Benzene levels shoot up, cold makes things worse for public, *available at:* https://www.financialexpress.com/india-news/air-pollution-in-delhi-benzene-levles-shoot-up-growing-cold-makes-things-worse-for-public (last visited on Dec. 18, 2021).

be contributing the most to pollution from the transport sector and associated disease burdens. This has serious implications for India that is in grip of dieselization. Earlier, the World Health Organization has linked diesel emissions to lung cancer and branded it as Class I carcinogen. Thus, there is urgent need to take stringent action to curb dieselization and reduce transport sector pollution effectively in order to cut toxic exposures. Vehicles are responsible for very high exposures and health burden in our cities.‡‡‡‡‡‡‡‡‡

Probably caused by the pollution, at 4,750 cases per 100,000 people, the Indian Council of Medical Research (ICMR) has estimated that in a year, the population of Jammu and Kashmir loses 3,039 disability-adjusted life years and the Chronic Obstructive Pulmonary Disease is highest in India in this small Himalayan territory.§§§§§§§§§A news titled 'Alarming high level of air pollution recorded in Jammu City' published in Kashmir Times revealed that the Jammuitessuffered from maximum respiratory diseases in 2016 to 2018 amongst all diseases. As many as thousands of cases related to acute respiratory infection were registered during last three years.********** A recent study released by the University of Chicago has found that residents in Jammu may be losing upto 4 years of their lives because of breathing polluted air.†††††††††† Moreover, the trio of accessibility, availability and affordability of healthcare facilities holds paramount importance in order to mitigate the burden of air pollution emergencies. At this juncture it is important to mention that Government Medical College, Jammu is the only major referral hospital for all ten districts of the region unlike Kashmir, which has four major referral hospitals that consequently adds more stress on the healthcare system in Jammu district.

It is important to mention here that J&K Pollution Control Board carries ambient air quality monitoring in Jammu city to assess the level of only RSPM, SPM, PM 2.5, SO_2, and NO_2 whereas no effort has been made to assess other pollutants including respirable lead, carbon monoxide, benzene, ammonia, ozone etc., in Jammu city despite the fact that the Jammu city has been categorized under 'non-attainment city' and the major burden shared by vehicular exhausts includes these pollutants also and in most of the cities, a total of 12 pollutants are already being monitored. Even till date J&K PCB is not able to establish a single Continuous Ambient Air Quality Monitoring Station in Jammu City while the same has been established in Srinagar City that too in the recent past.

Conclusion

Though it is much more complex to deal with emission from vehicles than emission from stationary sources yet a comprehensive policy focusing on vehicle inspection and monitoring, use of cleaner fuels, traffic management, check on fuel adulteration, parking policy, efficient public transport system, improvement in road infrastructure which would involve widening of roads, constructing new

35. Vehicular fumes escalate deaths and illness: New global study, *available at:* https://ww.downtoearth.org.in/news/air/vehicular-fumes-escalate-deaths-and-illness-new-global-study-63382 (last visited on Dec.9, 2021).
36. Breathing Srinagar's Air right now is like smoking 40 Cigarettes a day, available at: https://www.risingkashmir.com/--Breathing-Srinagar-s-Air-right-now-is-like-Smoking-40-Cigarettes-A-Day-97284
37. *Supra* note8.
38. *Supra* note 9.

express ways and highways, and development of Mass rapid transport system may go a long way in reduction of overall emission from land based transport sector and also enhance public convenience. Further, there is need to strengthen the existing air quality monitoring network in Jammu city, and inclusion of other criteria pollutants emitted from vehicles under monitoring programme to formulate comprehensive strategies to undo their effects on environment and health. Nevertheless, improving human health and well-being is the ultimate goal of all technological developments. The development that takes toll on human health needs thorough revision with robust regulations. To conclude, air pollution from automobiles is unnecessary, and convenience does not have to come at a price of harming the environment and health of the common populace.

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2. Report: China emissions exceed all developed nations combined, *available at:* https://www.bbc.com/news/world-asia-57018837 (last visited on Dec. 9, 2021).
3. Bindu ShajanPerappadan,"1.7 million deaths in India were attributable to air pollution in 2019" *The Hindu,* Dec. 22, 2020.
4. India secured 168 rank in the 12th edition of the biennial Environment Performance Index (EPI Index 2020) — that measured the environmental performance of 180 countries. The country scored 27.6 out of 100 in the 2020 index, *available at:*https://www.downtoearth.org.in/news/wildlife-biodiversity/india-must-redouble-sustainability-efforts-environment-performance-index-71603 (last visited on Dec. 9, 2021).
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