Air quality status of Nepal 2016-2020

Main report

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Babarmahal, Kathmandu

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Acknowledgements

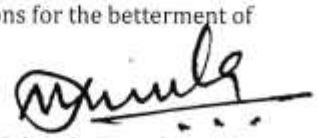
In collaboration with various organizations, the Department of Environment (DoEnv) has installed 27 monitoring stations till 2020. These 27 stations are installed throughout the country and are equipped with air quality instruments that provides real-time data. This report presents an analysis of the data from these stations. Real-time data up to one week period can be directly visualized from www.pollution.gov.np.

Except for a summary report of 2017 published electronically, this is the first point of departure in terms of report generation since data collection started in 2016. This report contains explanatory notes, graphs, and time series analysis, and is structured with a summary report as well as a 25 station-wise individual reports. These reports contain the analysis of particulate matter only but the future reports will definitely contain analyses of other parameters as well.

We are grateful to the International Centre for Integrated Mountain Development (ICIMOD) for supporting Department of Environment in establishing a number of Air Quality Monitoring Stations (AQMS) as a part of the national Air Quality Monitoring Network, and for providing technical support to the Department of Environment. We also thank the Asian Development Bank (ADB) for providing four dust monitors. We are also grateful to US Embassy in Kathmandu for establishing two AQMS – one on the embassy premises, and the other in Fohara Durbar.

We are thankful for the support provided by Dr Biswo Nath Oli, Former secretary, MoFE. We are extremely grateful to to Dr Pem Narayan Kandel, Secretaty Ministry of Forest and Environment, Mr Indu Bikram Joshi, Deputy Director General of DoEnv, Mr Shankar Prasad Poudel, Section Head of Environmental Pollution Monitoring and Regulation, and all other section heads for their active and constructive comments and encouragement during report preparation. We appreciate the data analysis team members comprising of the environment inspectors – Ms Nabina Maharjan, Mr Govinda Prasad Lamichhane, Ms Sunita Phuyal, Mr Bishnu Pandey, Ms Swasti Shrestha, Ms Hasana Shrestha, Mr Keshab Raj Joshi and Mr Rajeshwor Paudel for their continuous and rigorous hard work that has led to this report. Furthermore, a special thanks to all the staff of DoEnv, and everybody who has contributed to parts of this report, its editing and design. Lastly, the DoEnv is highly obliged to the Ministry of Forests and Environment for its continuous support and guidance in preparing the report.

The Department of Environment is always keen to receive suggestions for the betterment of our reports.



Mukunda Prasad Niroula
Director General

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Abbreviation

ADB	Asian Development Bank
AQMS	Air quality monitoring station
CO	Carbon monoxide
DHM	Department of Hydrology and Meteorology
GBS	Gandaki Boarding School
ICIMOD	International Centre for Integrated Mountain Development
NAAQS	National Ambient Air Quality Standards
NITC	National Information Technology Center
NOx	Nitrogen oxide
PM	Particulate matter
PU	Pokhara University
SO_2	Sulphur dioxide
TSP	Total suspended particulates

Chapter 1: Introduction

1. Background

1.1 Air quality

Air pollution causes both short- and long-term health impacts along with environmental damage. Rapid population growth, rapid and environment unfriendly industrialization, and urbanization are prime anthropogenic causes responsible for air pollution. As the negative consequences of air pollution increase and become evident, concerns about air quality have also increased amongst the people in Nepal. This demands the establishment and operation of air quality monitoring stations that can provide real-time data of air quality in specific areas and across the whole country.

Being the national focal institution for environmental issues, the Department of Environment under the Ministry of Forests and Environment, in collaboration with other organizations, established the real-time air quality monitoring station in 2016. The The International Centre for Integrated Mountain Development (ICIMOD) and Asian Development Bank (ADB) have significantly contributed to the establishment of Air Quality Monitoring Stations (AQMS).

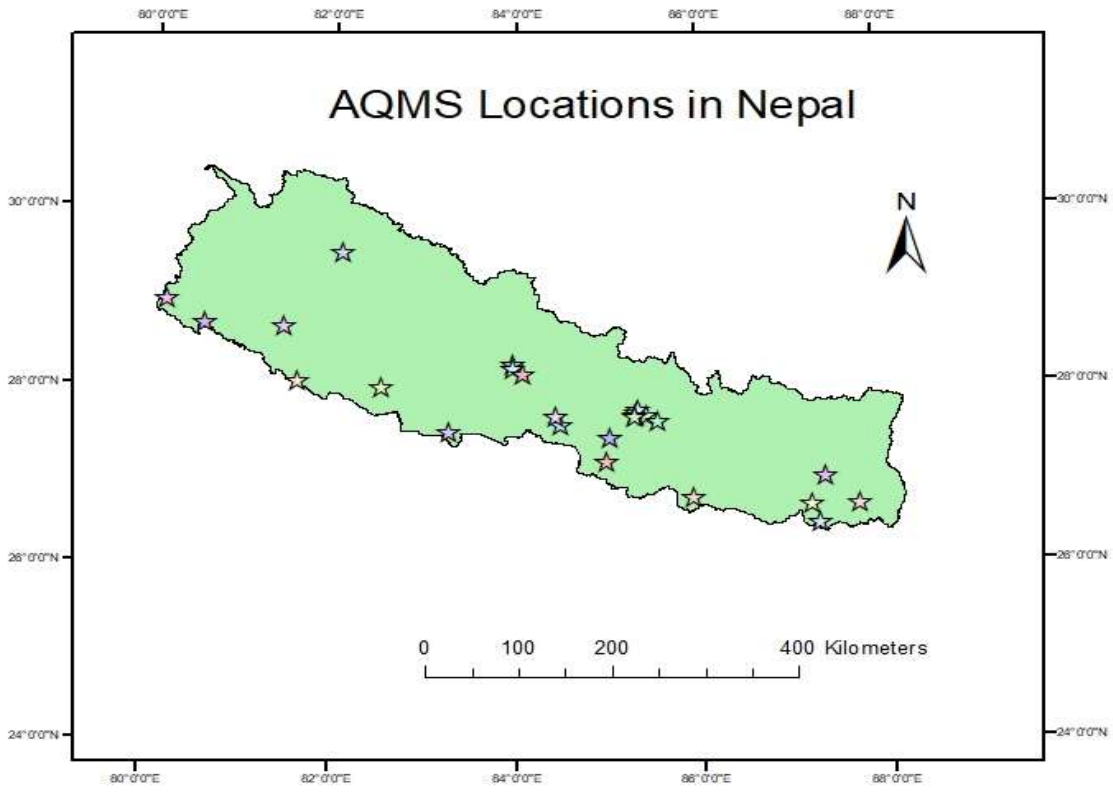

Figure 1: Distribution of air quality monitoring stations in Nepal

From 2016 to June 2021, the total number of air quality monitoring stations has reached 27, including the black carbon monitoring station at Yala, Langtang (Figure 1), all of which provide real-time air quality data.

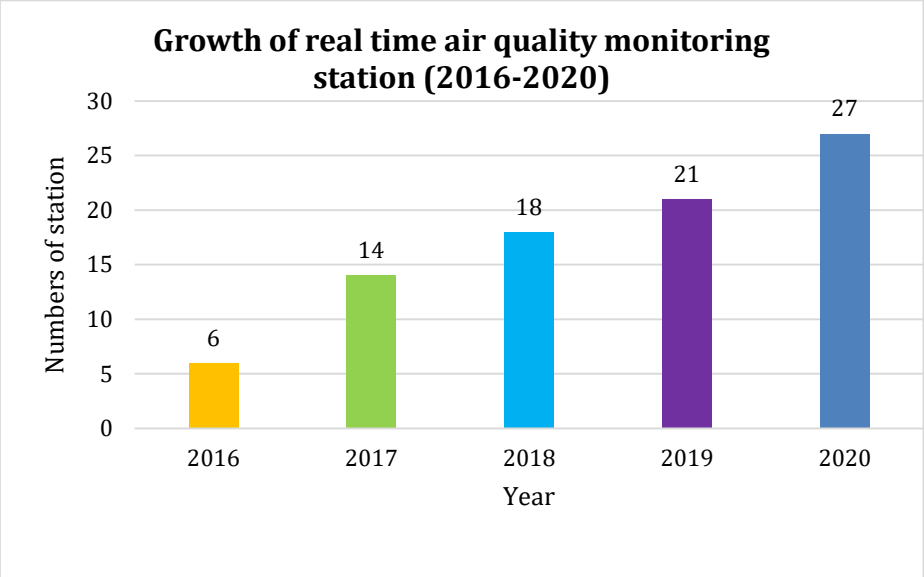

Figure 2: Growth of real-time air quality monitoring stations from 2016 to 2020

Province wise, a number of AQMS are located in Bagmati province and very few in Karnali province as shown below –

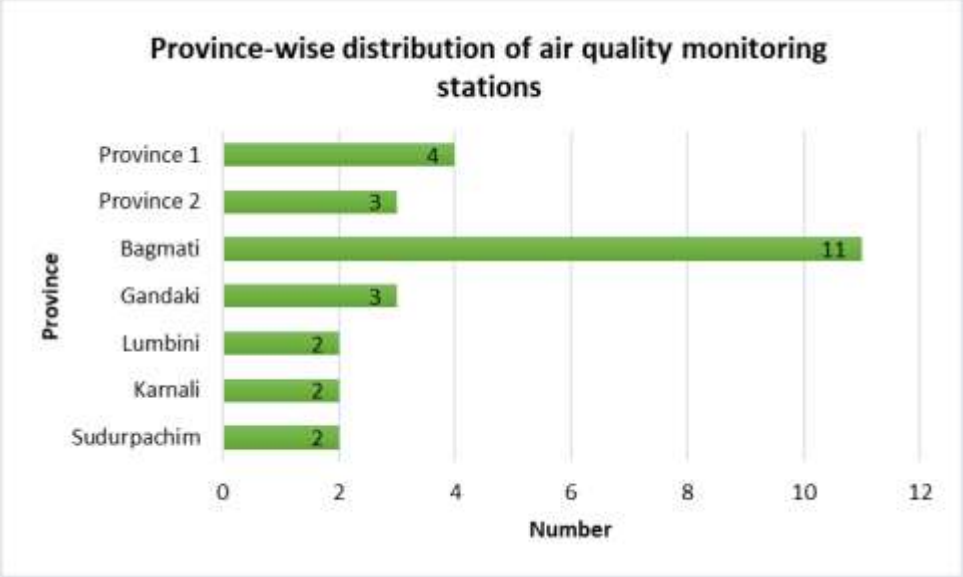

Figure 3 : Province-wise distribution of AQMS

All stations except for the one in Yala measure the following major parameters – PM_1, $PM_{2.5}$, PM_{10} and Total Suspended Particulates (TSP), as well as additional parameters such as ozone, CO, SOx, NOx in a few stations. The measurement of these parameters is essential not

only for the management of the current air quality but also to forecast future air pollution situations, which can assist in preventing possible air pollution-induced hazards. Additionally, the data generated forms a scientific basis for formulating policies and related legal documents to address air pollution-related issues.

The Government of Nepal has enforced the National Ambient Air Quality Standards (NAAQS), 2012 for nine parameters. This report has been prepared based on the analysis of data from all available monitoring stations for the period from 2016 to 2020 to understand the status of compliance with reference to the National Ambient Air Quality Standards (NAAQS).

1.2 Objectives

The overall objective of this report is to present the status of the air quality on the basis of the data collected from the 24 stations from 2016-2020.

The report also analyzes PM_{1}, $PM_{2.5}$, PM_{10}, and the Total Suspended Particulate Matter (TSP) data of the various stations.

1.3 Air quality parameters monitored

The following parameters were monitored in the stations.

TSP: Includes all solid and liquid droplet particulate present in the air with size more than 0.25μm.

PM_{10}: Includes particulate matter with an aerodynamic diameter less than 10 μm

$PM_{2.5}$: Includes particulate matter with an aerodynamic diameter less than 2.5 μm diameter and important in terms of health impacts.

PM_{1}: Includes particulate matter with an aerodynamic diameter less than 1μm diameter; important in terms of health impacts.

1.4 Methods of air quality monitoring and data analysis

The Grimm Electronic Dust Monitor(EDM) 180 is used for air quality monitoring. It uses the laser light-scattering technology for particle count. A semiconductor-laser serves as the light-source. The particle size analyzer/dust monitor determines the dust-concentration (counts/litre) through the optical-light-scattering method directly; however, the mass concentration is automatically calculated.

The instrument takes measurements every minute. The station then sends this data to the central server located at the National Information Technology Center (NITC), Singha Durbar, Kathmandu. From these point data, an hourly average data is calculated. For this analysis, the hourly average data was downloaded from the data management system, which was used to calculate the daily average. From they daily average, monthly average, seasonal average, and annual average were calculated. For years with less than six months data, the annual average was not calculated. Furthermore, data from the month of December of the

preceding year was used for calculating the air quality during the winter season. The report has excluded seasonal averages for years where data for only one season was available. The histograms were plotted using the hourly average data. Similarly, boxplots of the diurnal variation and monthly variation have been plotted using the hourly average data.

This report is a compilation of reports of 24 individual stations in 24 different volumes, summary of which is attached in annex 1.

Table 1 Name of AQMS with volume of report

Volume 1	Dhulikhel	**Volume 10**	Pokhara University	**Volume 18**	Surkhet
Volume 2	Lumbini	**Volume 11**	Shankhapark	**Volume 19**	Bharatpur
Volume 3	Pulchowk	**Volume 12**	Dang	**Volume 20**	Bhimdatta
Volume 4	Ratnapark	**Volume 13**	Jhumka	**Volume 21**	Biratnagar
Volume 5	Sauraha	**Volume 14**	Nepalgunj	**Volume 22**	Dhangadhi
Volume 6	Bhaisepati	**Volume 15**	Simara	**Volume 23**	Hetauda
Volume 7	Bhaktapur	**Volume 16**	Damak	**Volume 24**	Janakpur
Volume 8	DHM Pokhara	**Volume 17**	Dhankuta		
Volume 9	GBS Pokhara				

1.5 National Ambient Air Quality Standards, 2012 (NAAQS)

Government of Nepal has published National Ambient Air Quality Standards in 2012. The NAAQS gives maximum concentration for major nine parameters including particulate matters and trace gases, heavy metal and others as shown in the table below.

Table 2: National Ambient Air Quaity Standards, 2012

Parameters	Units	Averaging time	Maximum concentration
TSP	$\mu g/m^3$	24-hr	230
PM_{10}	$\mu g/m^3$	24-hr	120
Sulfur Dioxide	$\mu g/m^3$	Annual	50
		24-hr	70
Nitrogen Dioxide	$\mu g/m^3$	Annual	40
		24-hr	80
Carbon monoxide	$\mu g/m^3$	8-hr	10,000
Lead	$\mu g/m^3$	Annual	0.5
Benzene	$\mu g/m^3$	Annual	5
$PM_{2.5}$	$\mu g/m^3$	24-hr	40
Ozone	$\mu g/m^3$	8-hr	157

1.6 Air quality status – Kathmandu

Kathmandu valley has seven air quality monitoring stations in different parts of the valley, including in Dhulikhel – Ratnapark, Sankhapark, Bhaisepati, Pulchowk, Bhaktapur, and Kirtipur. The following graph shows the air quality status of Kathmandu.

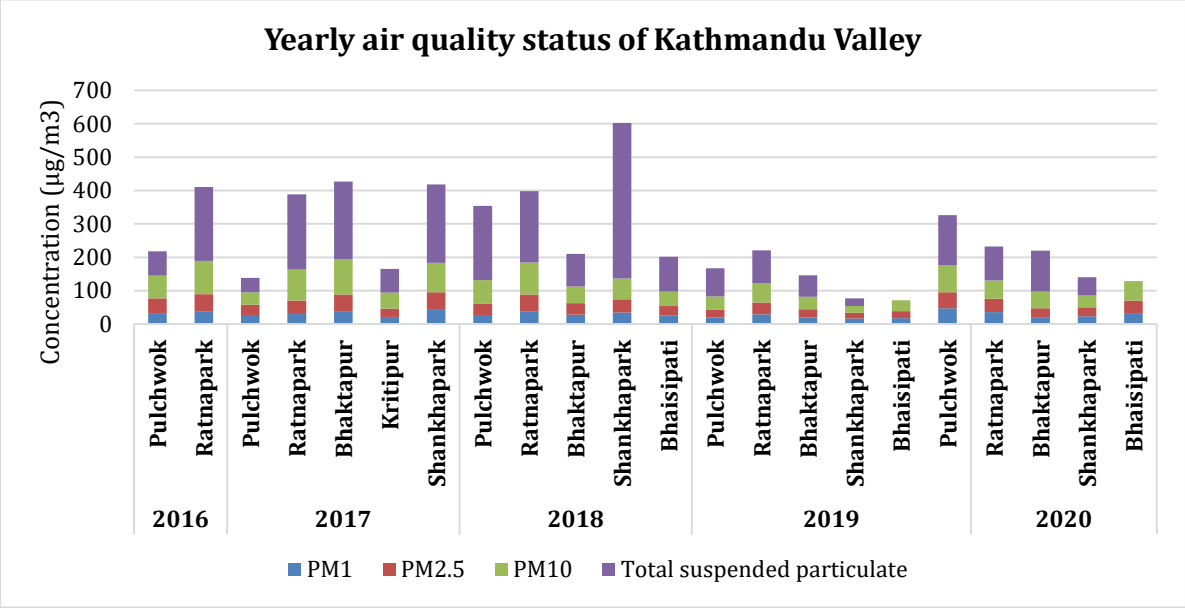

Figure 4: Air quality status of Kathmandu Valley

1.7 Air quality status – Pokhara

Pokhara valley has three air quality monitoring stations located at the Department of Hydrology and Meteorology (DHM), Pokhara University (PU), and Gandaki Boarding School (GBS). The following graph shows the air quality status of Pokhara.

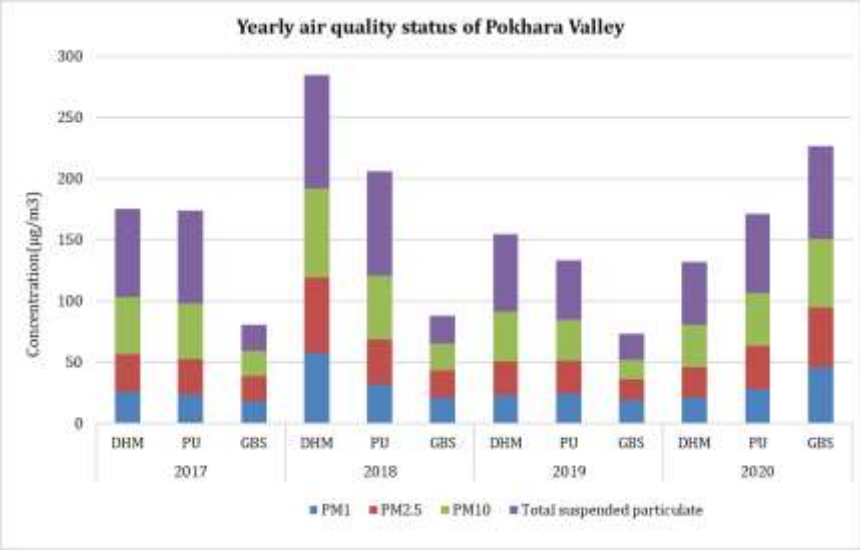

Figure 5: Yearly air quality status of Pokhara Valley

Annex 1: Summary sheet

Volume	Station	Parameters	Time period															
			2016			2017			2018			2019			2020		
			Annual average	Compliance status		Annual average	Compliance status		Annual average	Compliance status		Annual average	Compliance status		Annual average	Compliance status	
				Total days of measurement	Days exceeding NAAQS		Total days of measurement	Days exceeding NAAQS		Total days of measurement	Days exceeding NAAQS		Total days of measurement	Days exceeding NAAQS		Total days of measurement	Days exceeding NAAQS
1	Dhulikhel	PM_1	30.52			25.32			25.23			23.66			21.38		
		$PM_{2.5}$	42	62	6	31.08	279	74	30.47	356	91	27.19	220	41	22.25	241	29
		PM_{10}	64.17		1	55.68	279	10	48.54		14	40.31	221	2	23.56		0
		TSP	118.12		2	131.71	279	37	97.27		30	61.25	220	5	24.1		0
2	Lumbini	PM_1				46.57			34.68								
		$PM_{2.5}$		20	20	51.49	309	158	38.99	253	88		103	50		28	12
		PM_{10}			20	71.75		206	51.23	252	136			77			22
		TSP															
3	Pulchowk	PM_1				27.28			27.33			19.58			jan feb		
		$PM_{2.5}$		68	43	31.03	336	103	34.74	322	107	23.23	353	37		51	42
		PM_{10}			1	37.18		0	69.66	322	53	39.57		0			3
		TSP			0	42.5		0	222.06	136	73	84.31		2			4
4	Ratnapark	PM_1				29.84			38.98			29.05			36.19		
		$PM_{2.5}$		111	75	40.95	336	131	49.72	317	180	35.88	320	142	39.96	230	78
		PM_{10}			32	92.48		72	95.3	306	92	57.7		42	54.97	217	31
		TSP			52	225.47		105	214.08	317	137	98.28		36	101.1	228	27
5	Sauraha	PM_1				49			24			28			28		
		$PM_{2.5}$				48	347	178	30	252	67	32	287	115	32	162	46
		PM_{10}				60		33	41		5	43		6	38		2
		TSP				61		9		251	0			0			

6	Bhaisespati	PM_1							25.31			19.58			32.5		
		$PM_{2.5}$					142	77	28.61	352	80	23.23	338	54	37.59	359	140
		PM_{10}						122	43.7		79	39.57	352	79	59.03		29
		TSP						140	104.28		79	84.31	359	105	37.59		105
7	Bhaktapur	PM_1				36.78			28.24			19.78			20.68		
		$PM_{2.5}$				51.62	125	68	34.9	329	90	24.24	298	48	28.72	214	37
		PM_{10}				106.21		97	49.49		41	37.83		26	49.49	196	28
		TSP				231.91		122	97.94		159	64.58		28	122.73	213	50
8	DHM Pokhara	PM_1							57.96			23.39			21.21		
		$PM_{2.5}$					136	47	61.07	248	208	27.45	332	73	24.5	250	46
		PM_{10}						0	72.76		5	40.55		0	34.69		1
		TSP						0	93.1		2	63.47		0	51.48		0
9	GBS Pokhara	PM_1				18.77			20.96			19.44			46.04		
		$PM_{2.5}$				19.93	130	4	22.36	234	33	16.63	299	3	48.71	334	131
		PM_{10}				20.9		0	22.28	208	3	15.71		0	56.02		63
		TSP				20.84		0	22.38	234	0	21.32		0	75.77		7
10	TU Kritipur	PM_1															
		$PM_{2.5}$					45	6									
		PM_{10}						0									
		TSP						2									
11	PU	PM_1							32.14			24.43			27.96		
		$PM_{2.5}$					138	42	36.45	260	121	27.18	255	61	35.21	216	76
		PM_{10}						0	51.76		9	32.79		0	43.58		0
		TSP						0	85.47		5	49.14		0	64.91		0
12	Sankhapark	PM_1				42.9			34.96			16.32			23.45		
		$PM_{2.5}$				51.91	108	77	38.98	175	94	17.64	267	16	26.48	252	33
		PM_{10}				88.31		19	62.99		5	20.46		0	35.3		1
		TSP				235.32	107	54	465.04	138	59	22.57		0	55.55		0
13	Da	PM_1										26.09			21.48		

		$PM_{2.5}$								80	61	31.53	346	112	26.15	311	52
		PM_{10}									7	53.99		31	44.2		157
		TSP									1	570.42		165	78.49		8
14	Jhumka	PM_1							142.8			49.38			103.61		
		$PM_{2.5}$							161.26	11	11	56.72	249	103	119.12		
		PM_{10}							201.75		11	76.48		64	152.72		
		TSP							272.96		9	113.11		54	203.01		
15	Nepalgunj	PM_1							48.27			46.03			23.34		
		$PM_{2.5}$							59.94	116	78	56.47	322	179	24.3	312	51
		PM_{10}							101.93		57	103.67		108	25.97		18
		TSP							196.68		50	210.34		89	26.7		40
16	Simara	PM_1										37					
		$PM_{2.5}$								170	64	38.11	361	164		170	44
		PM_{10}									51	42.57		5		184	58
		TSP									0	50.98		0		186	16
17	Damak	PM_1													57.09		
		$PM_{2.5}$											33	31	64.84	158	109
		PM_{10}											47	22	91.6		47
		TSP											47	14	141.6		22
18	Dhankuta	PM_1													41		
		$PM_{2.5}$											141	47	42	192	79
		PM_{10}												5	42		4
		TSP												119	162		53
19	Surkhet	PM_1															
		$PM_{2.5}$															
		PM_{10}															
		TSP															
20	Bharatpur	PM_1													29		
		$PM_{2.5}$													41	193	80
		PM_{10}													71		42

		TSP													162		53
21	Bhimdatta	PM_1													45.16		
		$PM_{2.5}$													45.15	161	78
		PM_{10}													84.93		52
		TSP													138.66		24
22	Biratnagar	PM_1													23.34		
		$PM_{2.5}$													24.3	169	69
		PM_{10}													25.97		35
		TSP													26.7		17
23	Dhangadhi	PM_1													52.7		
		$PM_{2.5}$													66.79	161	88
		PM_{10}													109.37		77
		TSP													176.07	162	66
24	Hetauda	PM_1													31.21		
		$PM_{2.5}$													37.25	146	60
		PM_{10}													59.39		9
		TSP													114.11		8
25	Janakpur	PM_1															
		$PM_{2.5}$														168	74
		PM_{10}														169	13
		TSP														156	1