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Assessment of industrial noise pollution in the Raipur region

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Abstract
A study of noise characteristics in some selected industrial area in Raipur region has been carried out. The study involves physical measurement of the noise levels using digital sound level meter and a social survey was conducted using questionnaire. Also, those living in the vicinity of the sawmill factories are particularly at high risk of excess noise exposure. Proper regulation should be put in place by both State and Local Governments and Industries should be located in designated non-residential area. Sound Intensity Modeling is been evaluated for all the industrial area and it is found that high Intensity of noise is found in all the area with various health issues. It is concluded that a risk of excess noise exposure exists among all the workers due to the very high noise levels found in this study.

Keywords: environmental toxicity, distribution, noise pollution, public health, modelling

Introduction
Environmental noise is currently becoming one of the most dominant types of environmental pollution. The effects of noise closely correlate with quality of life especially regarding the physical and psychological health of inhabitants, social and economic costs, thus impacting the sustainable development of a country [1]. Environmental noise management, therefore, is one of the most exigent tasks for environmental pollution management. The management of noise need to be developed in a comprehensive, integrative and cross-sectorial way, and appropriate methods and approaches for the management of noise impacts need to be found to deal with them in the most effective and sustainable manner at different governance levels, including national level that takes into account not only the requirements of the unions the country is a part of but also finds tailor made approaches [2-4].
Noise pollution is recognized as a major problem for the quality of life in urban areas all over the world. Because of the increase in the number of cars and industrialization, noise pollution has also increased. Noise in cities, especially along main arteries, has reached up disturbing levels [5]. Residences far from noise sources and near silent secondary roads are currently very popular. People prefer to live in places far from noisy urban areas [6].
The unit of noise is decibel, one-tenth of a bell and denotes as d(B), however the monitoring unit is considered as dB(A) Leq denotes the time weighted average 'A' of the level of sound in decibels on scale A and it has been found related to human hearing [7-9]. Thus in, dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear [10]. The unit of frequency is hertz (Hz) and is defined as the number of compressions and rarefactions per unit time (sec.). Human hearing is sensitive to frequencies in the range of about 20-20,000 Hz (the audio frequency range) [11-20]. Sound pressure is used as the fundamental measure of sound (amplitude) as it is measurable directly by any standard instruments. The weakest sound pressure disturbance that can be detected by an "average" person at 1,000Hz has been found to be 20 µN/m2 and the largest 107 µN/m2 [21]. Because of such a wide range, the use of a linear pressure scale has been found to be non-scientific. It has been found convenient to employ sound pressure level, a quality, which is proportional to the logarithm of sound pressure. By this, the sound pressure range of interest is compressed between 0 to 130 Db [22-25].

Experimental
Study area
The Raipur city is one of most populated cities in India and it is a capital city of Chhattisgarh, state. A survey has been conducted at different Industrial locations i.e (Urla, Siltara, Birgaon, Bhanpuri, Sarona-sankara, Hirapur and Tilda) for one month i.e. at various location and an industrial corridor to assess ambient noise levels, Noise Intensity was monitored from different Industrial area such as Tilda 47 locations., Hirapur 17 locations., Bhanpuri 34 locations., Birgaon 13 locations., Urla 26 locations., Siltara 47 locations and Sarona 21 locations See. Figure 1.

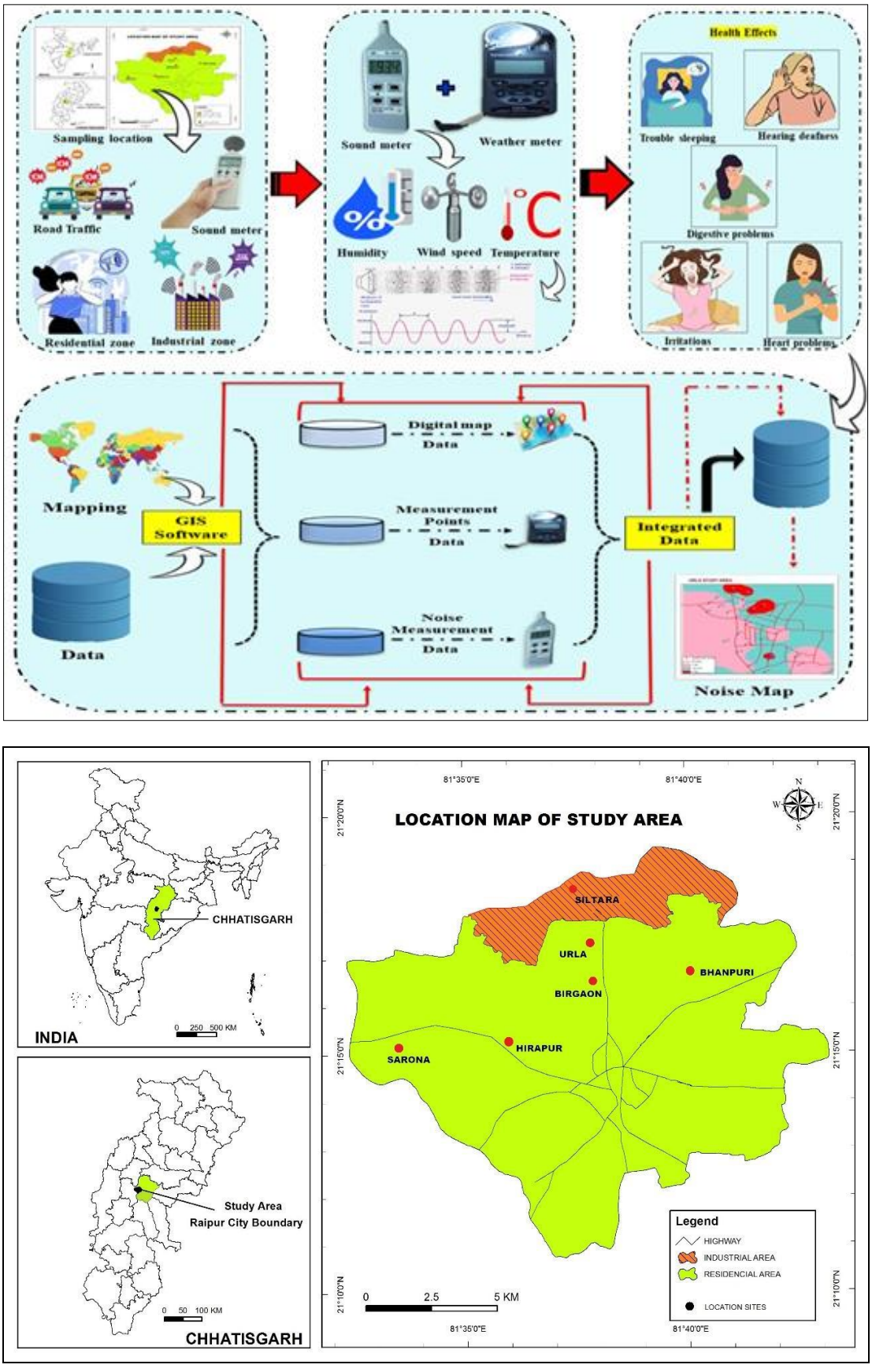


Fig 1: Representation of the sampling location.

Materials and Methods

Sound Level Meter and Meteorological sensors meter

The sound meter is been used for the assessment of various noise intensity from the different industrial area of Raipur and meteorological sensors is been used for the various meteorological parameters such as Temperature (T), Wind speed (WS), Humidity (H) etc.

Result and Discussions

Noise Intensity in various Industrial Area

The total observed intensities of the sound in all seven industrial areas i.e (Siltara, Urla, Bhanpuri, Birgaon, Hirapur, Sarona and Tilda) is been summarized in the Table 1. The Sound intensity was in the increasing level accordingly with the industries location and various industries running in that particular areas. All the sampling locations points were taken from the various industrial region and covered all the points of that specific area for comparison and modeling of the noise intensity and were measured with very high sound intensity as compare to the industrial noise standards.

Heavy traffic noise and machine noise from the industries which were the main reason for the high intensity on such location. The highest intensity of the sound is been found in the Siltara Industrial area as it is most polluted and highest noise intensity Zone and various health issues found in the human health.

Sound intensity of Tilda Industrial area

The Intensity of the sound in tilda in minimum and Maximum intensity value is been ranged from 70 to 150 dB and the mean value with the confidence limit is ranged from 82.26±3.83 dB. The highest intensity of the noise is been found in the sampling location no T 32 i.e Krishna Nagar railway Fatak Tilda zone. The relation with the meteorological parameters such as Temperature., Wind Speed and Humidity are 19-23º C, 8-10 km/h and 47-65% with the mean value 20.61 ºC, 9.31 km/h and 56.74 % respectively. Table 1, Figure 2

Sound Intensity of Hirapur area

The Intensity of the sound in Hirapur in minimum and Maximum intensity value is been ranged from 78 to 187 dB and the mean value with the confidence limit is ranged from 111.35±11.78 dB. The highest intensity of the noise is been found in the sampling location no HP 5 i.e Hirapur zone. The relation with the meteorological parameters such as Temperature., Wind Speed and Humidity are 22-27º C, 5-6 km/h and 31-35% with the mean value 25.59 ºC, 5.41 km/h and 33.35 % respectively, see Table 1 Figure 2

Sound Intensity of Bhanpuri industrial area

The Intensity of the sound in Bhanpuri in minimum and Maximum intensity value is been ranged from 68 to 199 dB and the mean value with the confidence limit is ranged from 101.29±10.79 dB. The highest intensity of the noise is been found in the sampling location no BH17 i.e K.H Industries and it is due to the industries that are running in that area. The relation with the meteorological parameters such as Temperature., Wind Speed and Humidity are 24-30º C, 6-13 km/h and 31-59% with the mean value 26.26ºC, 7.85 km/h and 51.56 % respectively. Table 1, Figure 2

Sound Intensity of Birgaon area

The Intensity of the sound in Birgaon in minimum and Maximum intensity value is been ranged from 71 to 198 dB and the mean value with the confidence limit is ranged from 102.93±11.82 dB. Table 1, Figure 2 The highest intensity of the noise is been found in the sampling location no BI 10 i.e Birgaon Industrial Complex and it is due to the industries that are running in that area. The relation with the meteorological parameters such as Temperature., Wind Speed and Humidity are 29-30º C, 13-18 km/h and 44-45% with the mean value 29.62 ºC, 15.85 km/h and 44.38 % respectively.

Sound Intensity of Urla Industrial area

The Intensity of the sound in Urla in minimum and Maximum intensity value is been ranged from 75 to 195 dB and the mean value with the confidence limit is ranged from 110.43±12.50 dB. The highest intensity of the noise is been found in the sampling location no U2 i.e Industrial area Urla and it is due to the industries that are running in that area. The relation with the meteorological parameters such as Temperature., Wind Speed and Humidity are 21-29º C, 3-16 km/h and 43-84% with the mean value 24.12ºC, 7.81 km/h and 61.65 % respectively. Table 1 and Figure 2

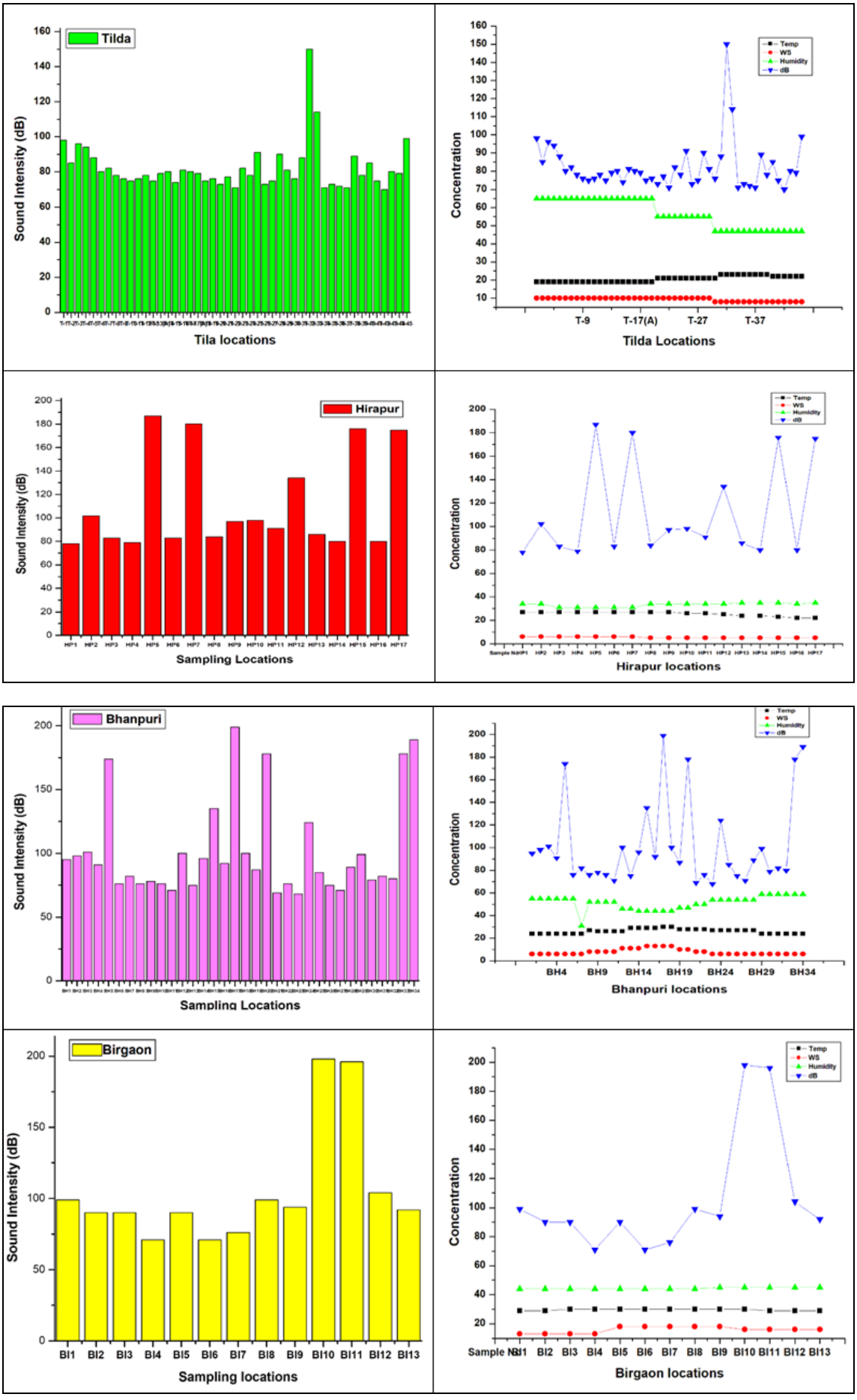
Sound Intensity of Siltara Industrial area

The Intensity of the sound in Siltara in minimum and Maximum intensity value is been ranged from 76 to 190 dB and the mean value with the confidence limit is ranged from 122.25±13.94 dB. The highest intensity of the noise is been found in the sampling location no SL7., SL14 and SL20 i.e Sarda Energy and Minerals LTD, M/S JCReclamation and SK Ispat Power Siltara no.2 and it is due to the main zone for various industries that are running in that area and values are found above the permissible limit i.e 75 dB. The relation with the meteorological parameters such as Temperature., Wind Speed and Humidity are 23-29º C, 3-6 km/h and 38-80% with the mean value 26.02 ºC, 4.68 km/h and 53.77 % respectively. Table 1, Figure 2

Sound Intensity of the Sarona/Sankara Industrial Area

The Intensity of the sound in Sarona/Sankara in minimum and Maximum intensity value is been ranged from 73 to 193 dB and the mean value with the confidence limit is ranged from 99.17±12.28 dB. The highest intensity of the noise is been found in the sampling location no SO13 i.e Aster private LTD Plot no. 73 Phase 1 Sondra and it is due to the industries that are running in that area. The relation with the meteorological parameters such as

Temperature., Wind Speed and Humidity are 26-28º C, 3-5 km/h and 38-41% with the mean value 27.10 ºC, 3.76 km/h and 39.71 % respectively. Table 1 and Figure 2



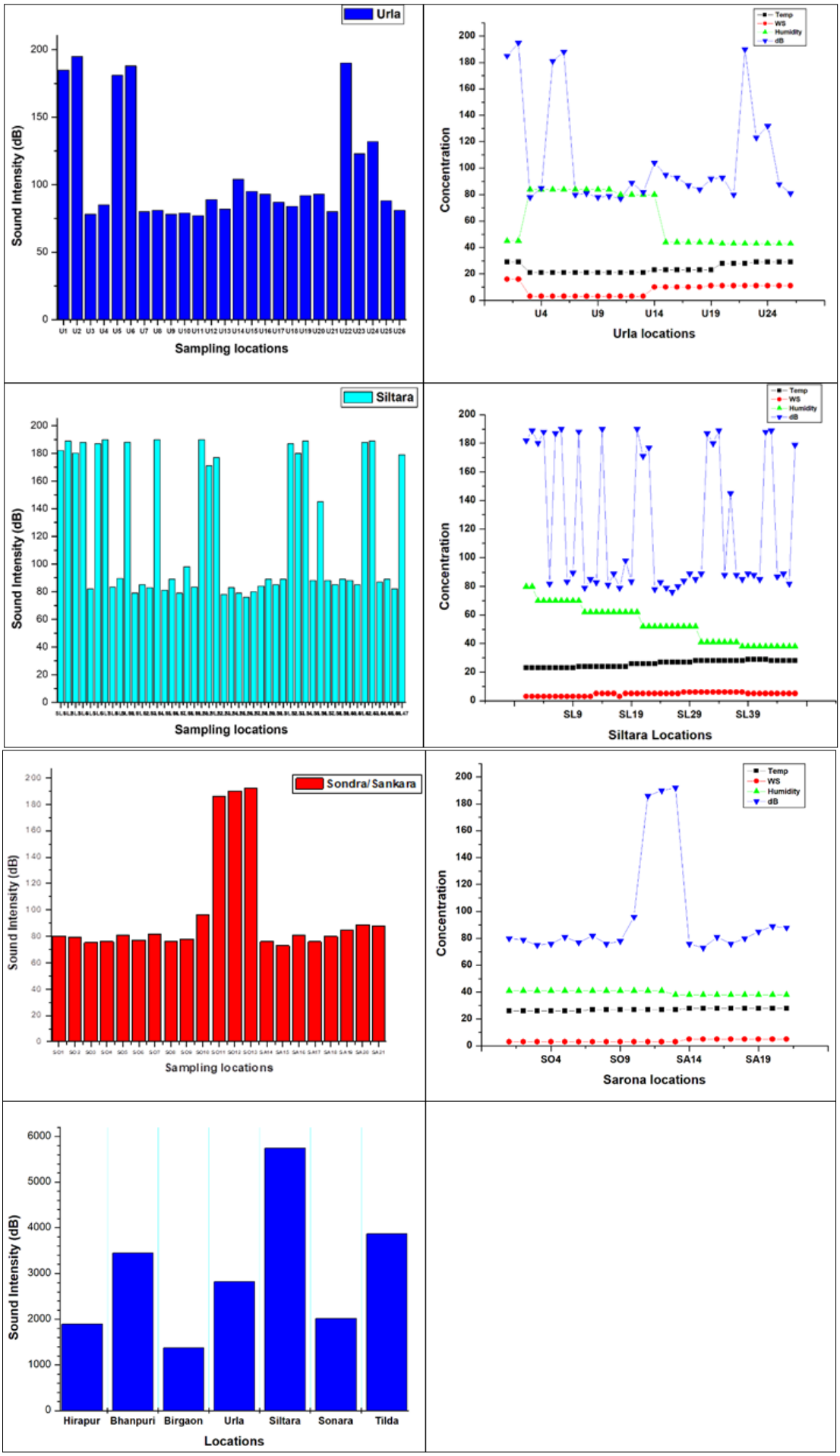


Fig 2: Sound Intensity of the Sorona/sankara area with weather intensity.

Table 1: Representation of the meteorological report with sound intensity (dB) of various Industrial area tilda.

Tilda Industrial Area							
S. No.	**Date**	**Sample No**	**Time**	**TºC**	**WS (km/h)**	**H (%)**	**Sound Intensity (dB)**
1	2/9/2020	T-1	11:35AM	19	10	65	98
2	2/9/2020	T-2	11:40AM	19	10	65	85
3	2/9/2020	T-3	11:45AM	19	10	65	96
4	2/9/2020	T-4	11:50AM	19	10	65	94
5	2/9/2020	T-5	11:55AM	19	10	65	88
6	2/9/2020	T-6	11:57AM	19	10	65	80
7	2/9/2020	T-7	12:01PM	19	10	65	82
8	2/9/2020	T-8	12:06PM	19	10	65	78
9	2/9/2020	T-9	12:10PM	19	10	65	76
10	2/9/2020	T-10	12:15PM	19	10	65	75
11	2/9/2020	T-11	12:20PM	19	10	65	76
12	2/9/2020	T-12	12:25PM	19	10	65	78
13	2/9/2020	T-13	12:31PM	19	10	65	75
14	2/9/2020	T-13(A)	12:35PM	19	10	65	79
15	2/9/2020	T-14	12:40PM	19	10	65	80
16	2/9/2020	T-15	12:44PM	19	10	65	74
17	2/9/2020	T-16	12:48PM	19	10	65	81
18	2/9/2020	T-17	12:51PM	19	10	65	80
19	2/9/2020	T-17(A)	12:55PM	19	10	65	79
20	2/9/2020	T-18	12:53PM	19	10	65	75
21	2/9/2020	T-19	01:01PM	19	10	65	76
22	2/9/2020	T-20	01:04PM	21	10	55	73
23	2/9/2020	T-21	01:08PM	21	10	55	77
24	2/9/2020	T-22	01:13PM	21	10	55	71
25	2/9/2020	T-23	01:20PM	21	10	55	82
26	2/9/2020	T-24	01:25PM	21	10	55	78
27	2/9/2020	T-25	01:30PM	21	10	55	91
28	2/9/2020	T-26	01:34PM	21	10	55	73
29	2/9/2020	T-27	01:39PM	21	10	55	75
30	2/9/2020	T-28	01:42PM	21	10	55	90
31	2/9/2020	T-29	01:46PM	21	10	55	81
32	2/9/2020	T-30	03:15PM	21	8	47	76
33	2/9/2020	T-31	03:28PM	23	8	47	88
34	2/9/2020	T-32	03:32PM	23	8	47	150
35	2/9/2020	T-33	03:40PM	23	8	47	114
36	2/9/2020	T-34	03:45PM	23	8	47	71
37	2/9/2020	T-35	03:52PM	23	8	47	73
38	2/9/2020	T-36	03:55PM	23	8	47	72
39	2/9/2020	T-37	03:59PM	23	8	47	71
40	2/9/2020	T-38	04:04PM	23	8	47	89
41	2/9/2020	T-39	04:09PM	23	8	47	78
42	2/9/2020	T-40	04:16PM	22	8	47	85
43	2/9/2020	T-41	4:20PM	22	8	47	75
44	2/9/2020	T-42	04:27PM	22	8	47	70
45	2/9/2020	T-43	04:32PM	22	8	47	80
46	2/9/2020	T-44	04:36PM	22	8	47	79
47	2/9/2020	T-45	04:41PM	22	8	47	99
Hirapur Industrial Area							
S No	**Date**	**Sample No**	**Time**	**T (ºC)**	**WS (km/h)**	**H (%)**	**Sound Intensity (dB)**
1	25/01/2020	HP1	4:26PM	27	6	34	78
2	25/01/2020	HP2	3:39PM	27	6	34	102
3	25/01/2020	HP3	3:31PM	27	6	31	83
4	25/01/2020	HP4	2:57PM	27	6	31	79
5	25/01/2020	HP5	2:45PM	27	6	31	187

6	25/01/2020	HP6	2:37PM	27	6	31	83
7	25/01/2020	HP7	1:58PM	27	6	31	180
8	25/01/2020	HP8	1:45PM	27	5	34	84
9	25/01/2020	HP9	1:03PM	27	5	34	97
10	25/01/2020	HP10	12:51PM	26	5	34	98
11	25/01/2020	HP11	12:38PM	26	5	34	91
12	25/01/2020	HP12	12:25PM	25	5	34	134
13	25/01/2020	HP13	12:08PM	24	5	35	86
14	25/01/2020	HP14	11:53AM	24	5	35	80
15	25/01/2020	HP15	11:08AM	23	5	35	176
16	25/01/2020	HP16	10:55AM	22	5	34	80
17	25/01/2020	HP17	11:44AM	22	5	35	175

Bhanpuri Industrial Area

S. No.	Date	Sample No	Time	T (ºC)	WS (km/h)	H (%)	Sound Intensity (dB)
1	28/01/2020	BH1	11:01AM	24	6	55	95
2	28/01/2020	BH2	11:12AM	24	6	55	98
3	28/10/2020	BH3	11:16AM	24	6	55	101
4	28/01/2020	BH4	11:25AM	24	6	55	91
5	28/01/2020	BH5	11:33AM	24	6	55	174
6	28/01/2020	BH6	11:42AM	24	6	55	76
7	28/01/2020	BH7	11:50AM	24	6	31	82
8	28/01/2020	BH8	11:56AM	27	8	52	76
9	28/01/2020	BH9	12:17PM	26	8	52	78
10	28/01/2020	BH10	12:27PM	26	8	52	76
11	28/01/2020	BH11	12:35PM	26	8	52	71
12	28/01/2020	BH12	12:49PM	26	11	46	100
13	28/01/2020	BH13	1:04PM	29	11	46	75
14	28/01/2020	BH14	1:25PM	29	11	44	96
15	28/01/2020	BH15	1:31PM	29	13	44	135
16	28/01/2020	BH16	1:41PM	29	13	44	92
17	28/01/2020	BH17	1:46PM	30	13	44	199
18	28/01/2020	BH18	1:53PM	30	13	44	100
19	29/01/2020	BH19	2:27PM	28	10	47	87
20	29/01/2020	BH20	2:10PM	28	10	47	178
21	29/01/2020	BH21	1:39PM	28	8	50	69
22	29/01/2020	BH22	1:18PM	28	8	50	76
23	29/01/2020	BH23	1:09PM	27	6	54	68
24	29/01/2020	BH24	1:02PM	27	6	54	124
25	29/01/2020	BH25	12:56PM	27	6	54	85
26	29/01/2020	BH26	12:47PM	27	6	54	75
27	29/01/2020	BH27	12:35PM	27	6	54	71
28	29/01/2020	BH28	12:22PM	27	6	54	89
29	29/01/2020	BH29	12:10PM	24	6	59	99
30	29/01/2020	BH30	11:56AM	24	6	59	79
31	29/01/2020	BH31	11:45AM	24	6	59	82
32	29/ 01/2020	BH32	11:38AM	24	6	59	80
33	29/01/2020	BH33	11:30AM	24	6	59	178
34	29/01/2020	BH34	11:18AM	24	6	59	189

Birgaon Industrial Area

S. No.	Date	Sample No	Time	T ºC	WS (km/h)	H (%)	Sound Intensity (dB)
1	28/01/2020	BI1	1:46PM	29	13	44	99

2	28/01/2020	BI2	1:53PM	29	13	44	90
3	28/01/2020	BI3	2:02PM	30	13	44	90
4	28/01/2020	BI4	2:51PM	30	13	44	71
5	28/01/2020	BI5	3:18PM	30	18	44	90
6	28/01/2020	BI6	3:26PM	30	18	44	71
7	28/01/2020	BI7	3:41PM	30	18	44	76
8	28/01/2020	BI8	3:50PM	30	18	44	99
9	28/01/2020	BI9	4:02PM	30	18	45	94
10	28/01/2020	BI10	4:11PM	30	16	45	198
11	28/01/2020	BI11	4:20PM	29	16	45	196
12	28/01/2020	BI12	4:32PM	29	16	45	104
13	28/01/2020	BI13	4:40PM	29	16	45	92

Urla Industrial Area

S.No.	Date	Sample No	Time	Temp (ºC)	Wind Speed (km/h)	Humidity (%)	Sound Intensity (dB)
1	28/01/2020	U1	4:42PM	29	16	45	185
2	28/01/2020	U2	4:48PM	29	16	45	195
3	29/01/2020	U3	10:38AM	21	3	84	78
4	29/01/2020	U4	10:48AM	21	3	84	85
5	29/01/2020	U5	10:53AM	21	3	84	181
6	29/01/2020	U6	10:58AM	21	3	84	188
7	29/01/2020	U7	11:05AM	21	3	84	80
8	29/01/2020	U8	11:12AM	21	3	84	81
9	29/01/2020	U9	11:18AM	21	3	84	78
10	29/01/2020	U10	11:22AM	21	3	84	79
11	29/01/2020	U11	11:31AM	21	3	80	77
12	29/01/2020	U12	11:38AM	21	3	80	89
13	29/01/2020	U13	5:01PM	21	3	80	82
14	29/01/2020	U14	4:54PM	23	10	80	104
15	29/01/2020	U15	4:50PM	23	10	44	95
16	29/01/2020	U16	4:44PM	23	10	44	93
17	29/01/2020	U17	4:38PM	23	10	44	87
18	29/01/2020	U18	4:30PM	23	10	44	84
19	29/01/2020	U19	4:19PM	23	11	44	92
20	29/01/2020	U20	4:12PM	28	11	43	93
21	29/01/2020	U21	4:05PM	28	11	43	80
22	29/01/2020	U22	4:01PM	28	11	43	190
23	29/01/2020	U23	3:31PM	29	11	43	123
24	29/01/2020	U24	3:38PM	29	11	43	132
25	29/01/2020	U25	3:34PM	29	11	43	88
26	29/01/2020	U26	2:51PM	29	11	43	81

Siltara Industrial Area

S No	Date	Sample no	Time	Temp (ºC)	Wind Speed (km/h)	Humidity (%)	Sound Intensity (dB)
1	2/5/2020	SL1	11:22AM	23	3	80	182
2	2/5/2020	SL2	11:30AM	23	3	80	189
3	2/5/2020	SL3	12:36PM	23	3	70	180.2
4	2/5/2020	SL4	12:42PM	23	3	70	188
5	2/5/2020	SL5	12:50PM	23	3	70	82
6	2/5/2020	SL6	12:56PM	23	3	70	187
7	2/5/2020	SL7	1:01PM	23	3	70	190
8	2/5/2020	SL8	1:04PM	23	3	70	83.4
9	2/5/2020	SL9	1:07PM	23	3	70	89.6
10	2/5/2020	SL10	1:12PM	24	3	70	188.2
11	2/5/2020	SL11	1:17PM	24	3	62	79
12	2/5/2020	SL12	1:21PM	24	3	62	85

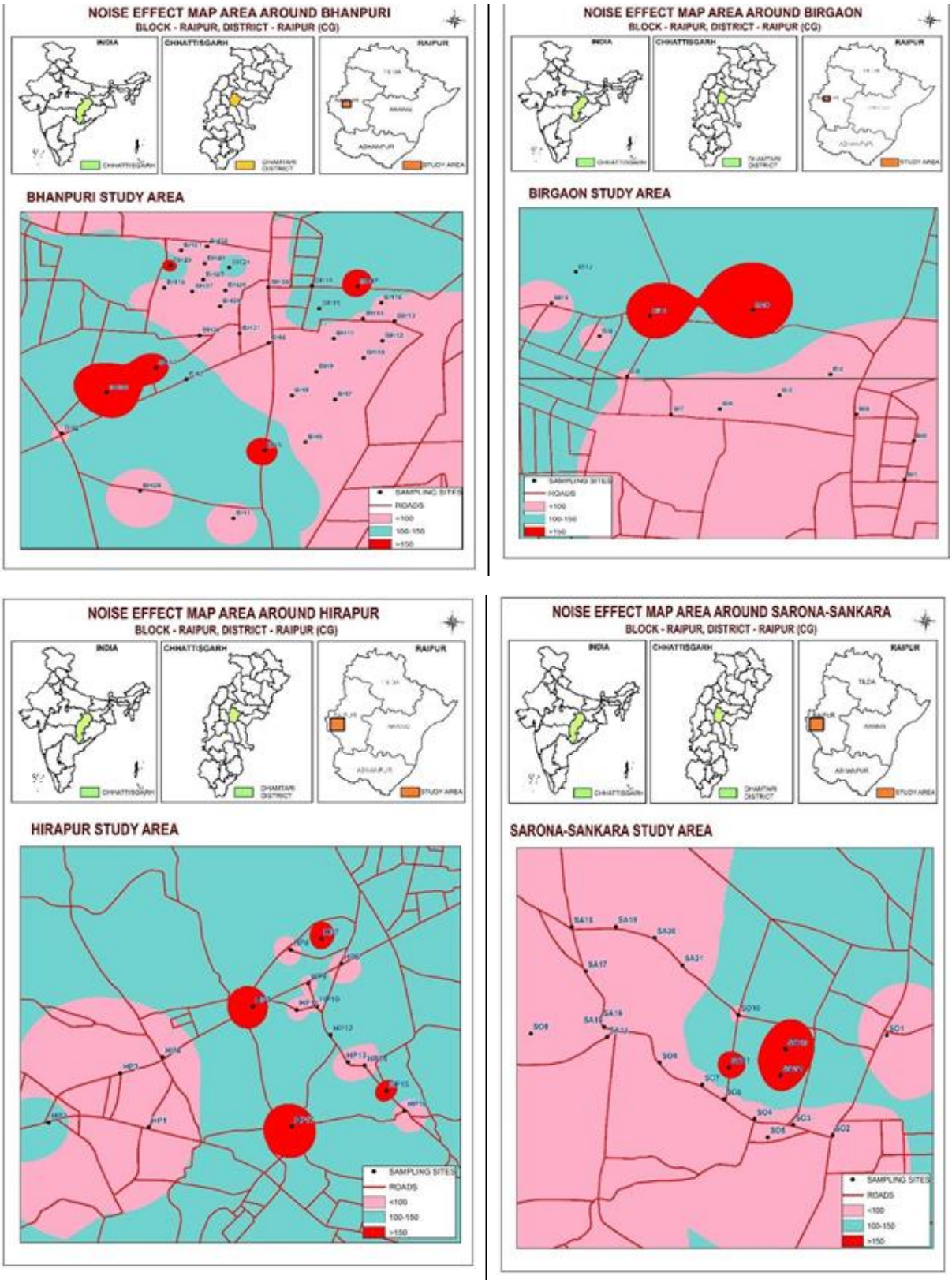
13	2/5/2020	SL13	1:26PM	24	5	62	82.9
14	2/5/2020	SL14	1:30PM	24	5	62	190
15	2/5/2020	SL15	1:36PM	24	5	62	81
16	2/5/2020	SL16	1:45PM	24	5	62	89
17	2/5/2020	SL17	1:50PM	24	3	62	79
18	2/5/2020	SL18	2:20PM	24	5	62	98
19	2/5/2020	SL19	2:32PM	26	5	62	83.5
20	2/5/2020	SL20	2:40PM	26	5	62	190
21	2/5/2020	SL21	2:47PM	26	5	52	171
22	2/5/2020	SL22	2:59PM	26	5	52	177
23	2/5/2020	SL23	3:07PM	26	5	52	78
24	2/5/2020	SL24	3:13PM	27	5	52	83
25	2/5/2020	SL25	3:17PM	27	5	52	79
26	2/5/2020	SL26	3:25PM	27	5	52	76
27	2/5/2020	SL27	3:31PM	27	5	52	80
28	2/5/2020	SL28	3:37PM	27	6	52	84
29	2/5/2020	SL29	3:42PM	27	6	52	89
30	2/5/2020	SL30	3:50PM	28	6	52	85
31	2/15/2020	SL31	12:58PM	28	6	41	89
32	2/15/2020	SL32	1:03PM	28	6	41	187
33	2/15/2020	SL33	1:06PM	28	6	41	180
34	2/15/2020	SL34	1:10PM	28	6	41	189
35	2/15/2020	SL35	1:13PM	28	6	41	88
36	2/15/2020	SL36	1:18PM	28	6	41	145
37	2/15/2020	SL37	1:20PM	28	6	41	88
38	2/15/2020	SL38	1:23PM	28	6	38	85
39	2/15/2020	SL39	1:26PM	29	5	38	89
40	2/15/2020	SL40	1:29PM	29	5	38	88
41	2/15/2020	SL41	1:33PM	29	5	38	85
42	2/15/2020	SL42	1:41PM	29	5	38	188
43	2/15/2020	SL43	1:44PM	28	5	38	189
44	2/15/2020	SL44	1:50PM	28	5	38	87
45	2/15/2020	SL45	1:57PM	28	5	38	89
46	2/15/2020	SL46	2:03PM	28	5	38	82
47	2/15/2020	SL47	2:08PM	28	5	38	179

Sarona Industrial Area

S No	Date	Sample No	Time	T (°C)	WS (km/h)	H (%)	Sound Intensity (dB)
1	2/15/2020	SO1	10:35AM	26	3	41	80
2	2/15/2020	SO2	10:41AM	26	3	41	79
3	2/15/2020	SO3	10:46AM	26	3	41	75
4	2/15/2020	SO4	10:53AM	26	3	41	76
5	2/15/2020	SO5	11:04AM	26	3	41	81
6	2/15/2020	SO6	11:12AM	26	3	41	77
7	2/15/2020	SO7	11:20AM	27	3	41	82
8	2/15/2020	SO8	11:30AM	27	3	41	76
9	2/15/2020	SO9	11:35AM	27	3	41	78
10	2/15/2020	SO10	12:34PM	27	3	41	96
11	2/15/2020	SO11	12:39PM	27	3	41	186
12	2/15/2020	SO12	12:43PM	27	3	41	190
13	2/15/2020	SO13	12:55PM	27	3	38	192
14	2/15/2020	SA14	11:48AM	28	5	38	76
15	15/02/2020	SA15	11:51AM	28	5	38	73
16	2/15/2020	SA16	11:54AM	28	5	38	81
17	2/15/2020	SA17	12:01PM	28	5	38	76
18	2/15/2020	SA18	12:03PM	28	5	38	80

19	2/15/2020	SA19	12:08PM	28	5	38	85
20	2/15/2020	SA20	12:23PM	28	5	38	89
21	2/15/2020	SA21	12:31PM	28	5	38	88

According to GIS Noise Standards the outdoor acceptable limits for industrial area in day time and night time is 75-65 dB(A). But as compared to this the observed values in the day time are more in all the location. An open-source Quantum GIS (QGIS) software is been used for the modelling. Data in Table 1 shows that maximum NC observed in industrial-cum-residential area was 7.9 between 4.00-5.00 pm. The intensity of the sound is been divided into three categories <100, 100-150 and >150. This indicates that the noise exposure is quiet high in this zone thereby causing annoyance among the human population. See Figure 3 (a-g)



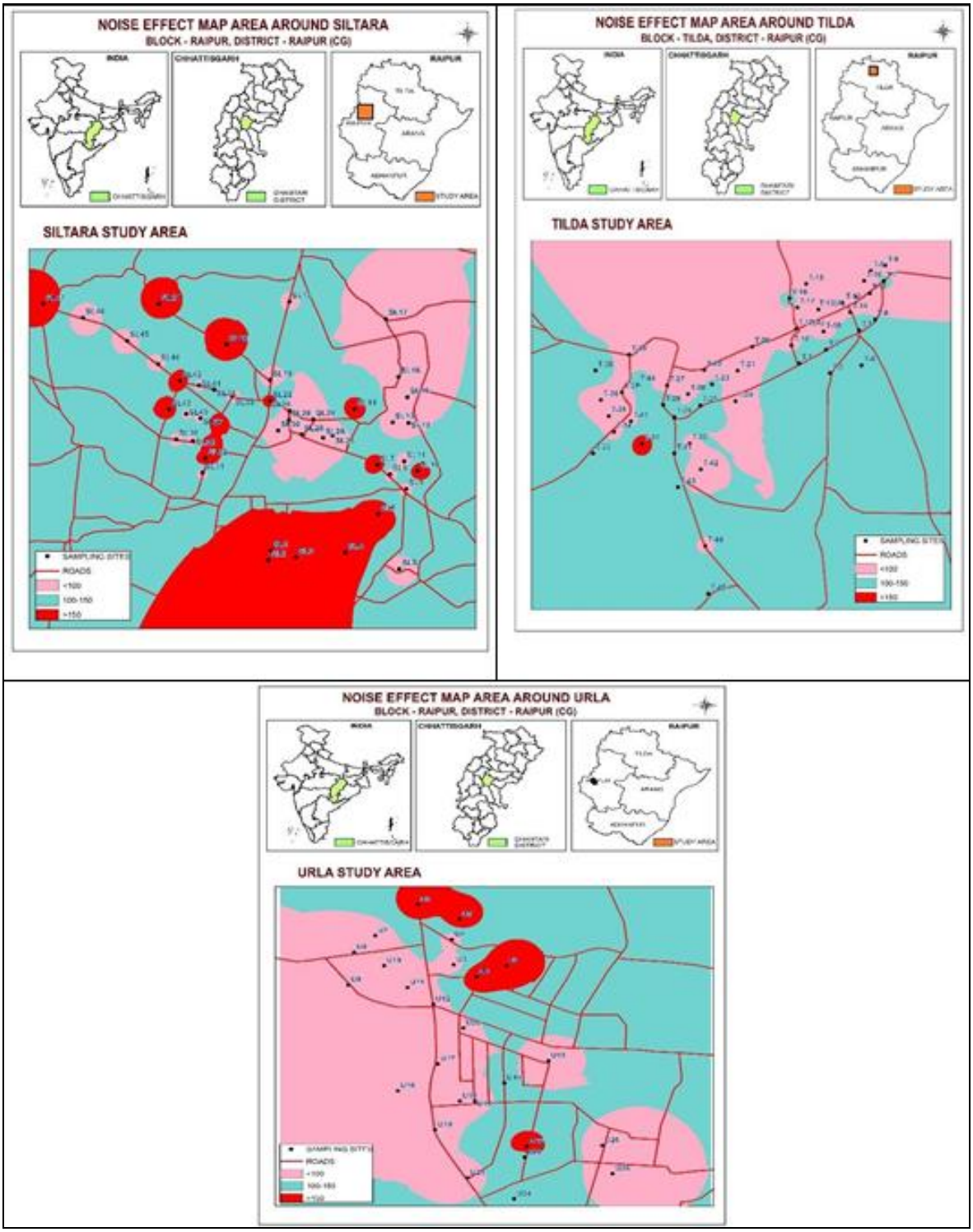


Fig 3: Noise Intensity Modeling for industrial area i.e Tilda, Hirapur, Bhanpuri, Birgaon, Urla, Siltara and Sarona-Sankara area.

Conclusion

Noise is an environmental pollutant that has effects on human well-being (including health and economic aspects), and that has to be managed in the sustainable and comprehensive way at different management levels. When analyzing environmental noise institutional system in Industrial area of Raipur region, it can be seen that the Noise consulting Board and municipal inspectorate are good practice examples, which could be a useful noise institutional model component for other countries. Also, guidelines, indicator system and national policy with an aim to reduce the number of affected inhabitants, is best practice. Noise management process improvements are related to the development of new intermediate body – Noise consulting board -, development of methodological tools, extending noise control as well as adding new procedural steps in the processes of EIA, development planning, object construction, noise mapping and action planning, development of legislation and others. Noise is an environmental pollutant that has effects on human wellbeing (incl. health and economic aspects), and that has to be managed in sustainable and comprehensive way at different management levels.

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