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RESEARCH ARTICLE

SCRUTINIZING THE WATER, AIR AND NOISE POLLUTION STATUS OF BARDDHAMAN MUNICIPALITY, WEST BENGAL USING GIS

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ABSTRACT

One of the fast growing urban centres of South Bengal is Barddhaman Town which is situated on the fertile Lower Damodar Floodplain (23°14′18″N and 87°51′39″E). Recently the urbanization process has been played a dual role in the socio-economic development and environmental degradation. The town has drastically increased its area and population size from 1970, as well as the urban healthy environment is deteriorated. This paper aims to analyse the environmental degradation in terms of pollution. So, we have been selected three aspects of urban pollution- Air, Water and Noise Pollution. Taking Pre-Monsoon and Monsoon measurements of SO_2, NO_2 and RSPM, we have found that there is high level of air pollution in the selected locations. Analyzing the chemical data of surface waterbodies and sediment samples of waterbodies, we have been traced the heavy metals' concentration in few locations. Side by side, the silence zones and dense residential areas are very much suffered from noise pollution in daytime. At last combining those results, graphs and spatial coverages of pollutions we have been prepared a ward-wise pollution risk map of Barddhaman Town using Geographic Information System.

INTRODUCTION

The phrase 'man and the land' is often used to convey the essence of geography. While the relationship of human to their earthly environment is a core concept in geography, an equally important idea is that the relationship has a certain distribution in space. Geographers recognize that the quality of life layer varies from place to place in terms of richness or poverty of life forms capable of being supported (Strahler, 1977). The word 'environment' does not exist as a sphere separate from human actions, ambitions and needs and attempts to defend it in isolation from human concerns have given the word 'environment' a connotation of some political circles. The report goes on to note that environment is where we all live……..and development is what we all do in attempting to improve out lot within their abode. The two are inseparable (Carry, 1996). During the last few years there has been a growing insight that towns and in general urbanized areas, have to be considered as cultural ecosystems. Towns and cities are the structured communities of various kinds of organisms (human, animals and plants) which have a certain structured set of relationships with the abiotic environmental factors: climate, soil, water and topography (Vink, 1983). At the centre of concern are human activities that degrade the environment and reduce its potential to support life. These activities are generally referred to as environmental impacts and they tend to fall into two categories- environmental pollution and environmental disturbance (Manivaskam, 1983). The cities of India are experiencing critical environmental degradation and pushing to the limit their ability to sustain human life. Although the entire urban population is affected, the urban poor are the most vulnerable. There is a need for evolving a system of environmental monitoring through measurement of environmental quality levels ensuring measures for disaster prevention and in the unavoidable event of a natural disaster, having a disaster management strategy. The scale of devastation is directly related to poor governance structures and lack of preparedness which increase vulnerability of population and settlements (Carry, 1996). India's urbanization is thrown up formidable challenges like running out of land resource, running out of water and even running out of clean air to breath. To understand the quality of environment of Barddhaman we have been considered the following objectives:-

(a) Providing a brief outlook of flaws of urbanization and changes of physical landscape.
(b) Indentifying, quantifying, analyzing and mapping the pollution status and
(c) Providing a pollution risk map and indentifying critical pollution prone areas.

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MATERIALS AND METHODS

The whole research is accomplished using the empirical observations and quantitative methods of environmental geography. The study can be grouped as a deductive study because the main hypothesis is that there are some sorts of pollutions in the town. The purpose of this geographical analysis is to find out the answer of the question: is there any glimpse of environmental pollution? If found then how much its magnitude and spatial extent over Barddhaman? The basic technique is to chalk out the patterns and magnitude of pollution in terms of quantitative information. In the pre-field session, toposheets (73 M/15 and M/16) of Survey of India, Google Earth imagery, District Resource Map of GSI, District Planning Map of NATMO, Ward map of municipality, satellite images (LANDSAT and IRS) of different time periods, Indian census report, pollution data and numerous literatures related to it are collected. Then that information is integrated in the great cartographic engine, i.e. Geographic Information System (GIS), creating an updated database. After creating a geo-referenced baseline ward map of Barddhaman, all the spatial information is represented as thematic maps and charts. To verify the spatial information frequent rechecking, ground observations and surveys are done and many photographs are taken to prove that information as reality (Figure 1).

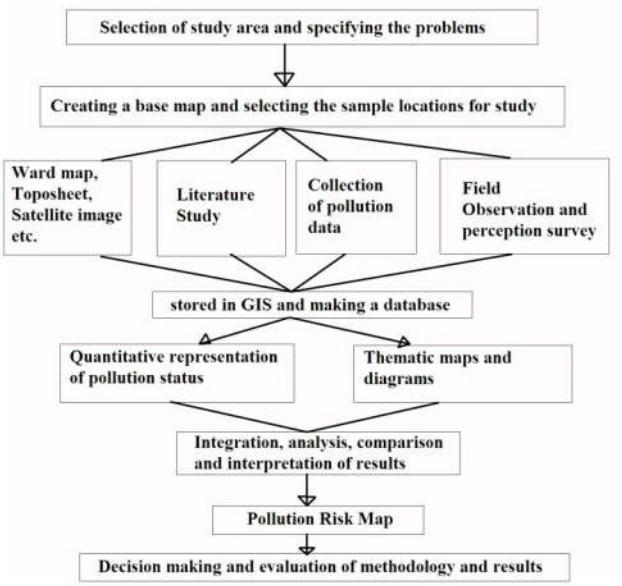


Figure 1.Flowchart of methodology adopted for this study

Geographical Outline of Barddhaman Town

Barddhaman or Burdwan (also Bardhaman; Bengali: ***Bôrdho man***), is a city of West Bengal state in eastern India. The first epigraphic reference to the name of this place occurs in a 6th century AD copper-plate found in Mallasarul village under Galsi Police Station. The origin of this name dates back to the 6th century BCE and is ascribed to Vardhaman Swami or Mahavira (599-527 BCE), the twenty-fourth JainTirthankar. The one of principal urban centres and civil stations of southern West Bengal is more or less centrally located in the Burdwan or Barddhaman district (23°14′18″N and 87°51′39″E). It is situated on the left bank of great river, the 'Sorrow of Bengal', Damodar. Barddhaman urban agglomeration is covered in the toposheets 72 M/15 and M/16 of Survey of India. Latitudinal extension varies from 23°13' to 23°16'N and longitudinal extension varies from 87°49' to 87°53'E. The Barddhaman Railway Station is well connected by eastern railway (main and chord line) and G.T. Road with its hinterland (Figure 2).

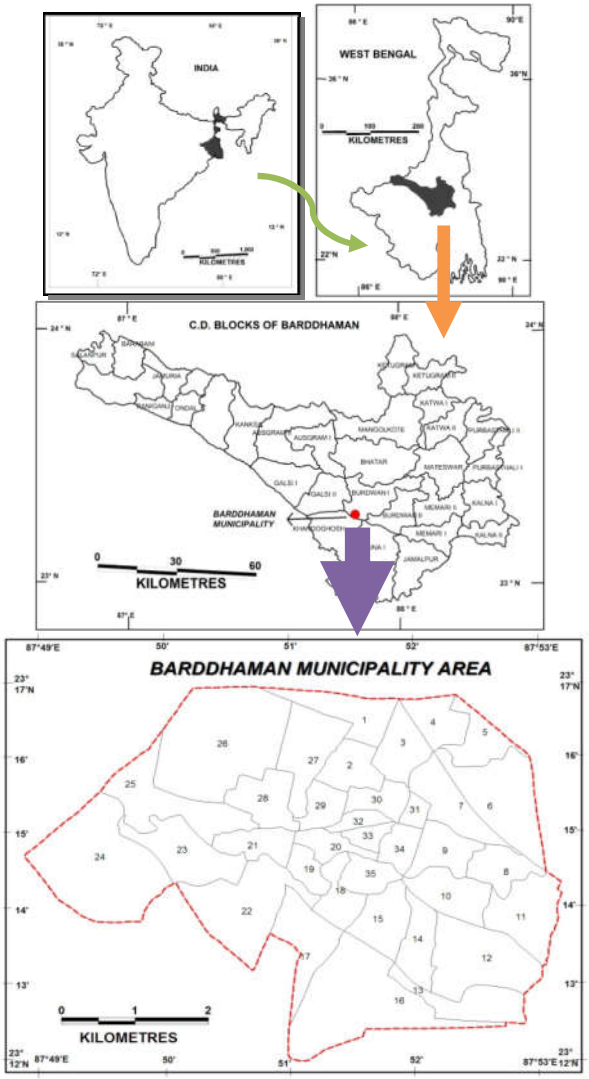


Figure 2. Location map of Barddhaman Municipality

After the political decision of 1947 the population did not decreased but the decadal growth was fluctuating. The intense urban growth was started to increase after 1961 and 46.7% of growth was recorded within 1981 and 1991. At the time of establishment of town (1865) the population was 39,618 and now the population is 285602 (2001) (figure 3). During 1961 the municipal area was 22.62 km^2; it is increased to 22.74 km^2 in 1981, 23.04 km^2 in 2001 and 26.54 km^2 in 2008. The present land use and land cover of this town signifies the anthropogenic stresses on the physical environment (table 1).

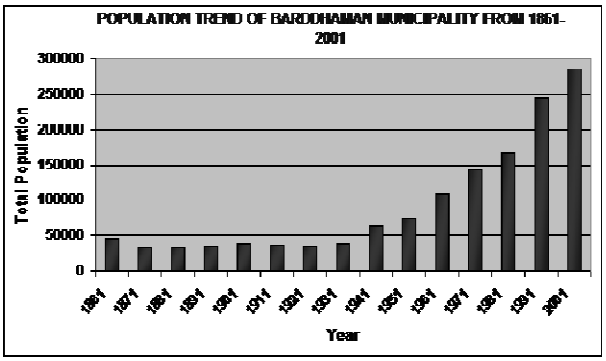


Figure 3.Population growth pattern (1861 to 2001) of Barddhaman town (data source: Konar, 2010)

Table 1.Distribution of land use and land cover in Barddhaman municipality (2007-08)

LAND USE AND LAND COVER	AREA IN km^2
Residential area	14.15
Industrial area	0.58
Institutions and Govt./semi/public land	0.39
Vegetation cover, Public parks and Play ground	2.26
Agricultural land	1.08
Water bodies and Wet-Swampy land	3.67
Railway and Roads	1.48
Others	2.93
TOTAL	26.54

Pollution

It is not easy to give a precise definition of 'pollution' or of the word 'polluting'. The Oxford English Dictionary defines 'pollute' and 'pollution' as follows: Pollute- destroy the purity or sanctity; make (water etc.) foul or filthy.

Pollution- the act of polluting

Environmental pollution may be described as the unfavourable alteration of our surroundings and occurs mainly because of the action of man (Mainvasakam, 1984). Pollution means the degradation of the environment as a result of contamination of some sort by chemicals, biological agents, sediment, radiation or heat (Marsh and Grossa, 1996).

Assessing the Water Quality

Water pollution may be defined as the adverse change in composition or condition of the water such that it becomes less suitable for the purposes for which it would be suitable in its natural state (Manivasakam, 1984). With the advantages of mature of deltaic alluvium plain, proximity to Damodar River, mean annual rainfall 140 cm, possibility of numerous aquifers, the main source of drinking water in the town is from ground water. At present Barddhaman municipality receives about 28.75 million litre of water per day, operating 37 submersible pumps. West Bengal Pollution Control Board (WBPCB) has been examined the pollution status of water bodies in the town and Geological Survey of India (eastern region) made an assessment report on the surface and ground water condition of Barddhaman urban agglomeration in 2003-2005.

Table 2.Complete chemical analysis of ground water samples (GSI, 2005)

Location	Source & Depth (m)	pH	HCO_3 ppm	Cl ppm	F ppm	Total Hardness as $CaCO_3$	Mg ppm	Na ppm	K ppm	Fe ppm	As ppb
Nawabhat	TW-27m	7.27	245	20	0.5	175	14	18.3	1	0.33	<10
Rathtala	TW-12m	6.84	85	10	0.3	55	6	5.6	3.1	0.55	<10
Baburbag	TW-21m	7.27	285	90	0.3	315	20	28	2.2	1.3	<10
Sadar Ghat	TW-12m	7.16	255	20	0.3	175	14	15.8	1.3	2.09	<10
Rasikpur	TW-100m	6.99	385	115	0.45	400	26	53	2.8	-	<20
Lakhudi	TW-100m	7.21	200	10	0.65	335	23	21	21	-	<20
Permissible Limit (IS 10500:1991) ppm		6.5-8.5	-	1000	1.5	-	100	-	-	1	0.05

Table 3.Complete chemical analysis of surface water samples (GSI, 2005)

Location	Source	pH	HCO_3 ppm	Cl ppm	F ppm	Total Hardness as $CaCO_3$	Mg ppm	Na ppm	K ppm	Fe ppm	As ppb
Krishnasayar	pond	9.07	80	35	1.1	105	11	18	22	-	<20
Kamalsayar	pond	8.88	95	80	0.85	55	7	68	39	-	-
Shaymsayar	pond	9.30	70	95	0.9	80	14	66	32	-	-
Ranisayar	pond	8.88	90	100	0.85	105	17	64	27	-	-
Sadhanpur	pond	9.18	225	100	0.45	150	16.8	61.6	20	1.4	-
Permissible Limit (IS 10500:1991) ppm		6.5-8.5	-	1000	1.5	-	100	-	-	1.0	0.05

Table 4.National ambient air quality standards

Pollutants ($\mu g/m^3$)	time weighted	concentration in ambient air in average		
		sensitive	industrial	residential and others
RSPM	24h	75	150	100
SO	24h	30	120	80
NO	24h	30	120	80

Source: Central Pollution Control Board, 1994

The borehole logs indicated that in the area under study two confined aquifers (occur up to depth of 146 metre below ground level) separated by intervening clay horizon having thickness ranging from 2 m to 6 m (GSI, 2005). The first

Table 5.Pre-Monsoon ambient air quality status in various locations of Barddhaman municipality (2009)

Sites	RSPM	S_1	SO_2	S_2	NO_2	S_3	PSI_{X1}	STATUS
I1	173.9	115.93	1.59	1.32	26.62	22.18	139.43	alert
I2	326.2	217.46	26.69	22.24	66.06	55.05	294.75	emergency
I3	154.6	103.06	8.6	7.16	20.19	18.49	128.71	alert
I4	231.1	154.06	19.46	16.21	56.09	46.74	217.01	emergency
R1	203.3	203.3	4.37	5.46	238.19	297.73	506.49	significant harm
R2	174.7	174.7	0.88	1.1	161.79	202.23	378.03	significant harm
R3	230	230	2.13	2.66	109.74	137.17	369.83	significant harm
R4	303.3	303.3	0.34	0.42	29.19	36.48	340.2	significant harm
R5	267.3	267.3	2.21	2.76	63.15	78.93	348.99	significant harm
R6	285.8	285.8	3.18	3.97	87.16	108.95	398.72	significant harm
R7	99.4	99.4	0.6	0.75	36.77	45.96	146.11	alert
R8	135.17	135.17	0.34	0.42	88.36	110.45	246.04	emergency
R9	119.16	119.16	3.17	3.96	63.04	78.8	201.92	emergency
R10	137.77	137.77	4.37	5.46	220.87	276.08	419.31	significant harm
R11	323.1	323.1	6.93	8.66	140.43	175.53	507.29	significant harm
R12	264.4	264.4	3.22	4.02	3.73	4.66	273.08	emergency
R13	69.61	69.61	2.69	3.36	16.1	20.12	93.09	negligible
R14	168.9	168.9	9.75	12.18	54.71	68.38	249.46	emergency
R15	96.54	96.54	2.75	3.43	158.82	198.52	298.49	emergency
S1	123.6	164.8	2.68	8.93	77.49	258.3	432.03	significant harm
S2	191.7	253.6	2.64	8.8	158.58	528.6	791	significant harm
S3	156.4	208.5	12.71	42.36	6062	208.73	459.59	significant harm
S4	363.6	484.8	2.72	9.06	101.46	338.2	832.06	significant harm
S5	60	80	0.57	1.9	79.57	265.23	347.13	significant harm
S6	54.45	72.6	3.5	11.66	191.87	639.56	723.82	significant harm

Table 6.Monsoonal ambient air quality status in various locations of Barddhaman municipality (2009)

Sites	RSPM	S_1	SO_2	S_2	NO_2	S_3	PSI_{X2}	STATUS
I1	74	49.33333	20.34	16.95	125.78	167.7067	233.99	emergency
I2	53.7	35.8	23.11	19.258333	60.29	80.38667	135.445	alert
I3	55.2	36.8	0.38	0.3166667	98.6	131.4667	168.5833	alert
I4	60.41	40.27333	7.51	6.2583333	23.81	31.74667	78.27833	negligible
R1	22.8	22.8	7.06	8.825	44.05	55.0625	86.6875	negligible
R2	15.46	15.46	1.47	1.8375	90.73	113.4125	130.71	alert
R3	34.26	34.26	NIL	0	230.51	288.1375	322.3975	significant harm
R4	38.92	38.92	10.6	13.25	163.69	204.6125	256.7825	emergency
R5	71.8	71.8	6.95	8.6875	191.21	239.0125	319.5	significant harm
R6	16.3	16.3	12.53	15.6625	168.7	210.875	242.8375	emergency
R7	40.97	40.97	9.11	11.3875	129.66	162.075	214.4325	emergency
R8	32.63	32.63	3.94	4.925	193.9	242.375	279.93	emergency
R9	10	10	20.34	25.425	207.12	258.9	294.325	emergency
R10	69.62	69.62	16.95	21.1875	426.28	532.85	623.6575	significant harm
R11	112.8	112.8	5.45	6.8125	79.05	98.8125	218.425	emergency
R12	102.46	102.46	5.6	7	166.7	208.375	317.835	significant harm
R13	47.16	47.16	1.32	1.65	30.34	37.925	86.735	negligible
R14	7.11	7.11	4.55	5.6875	45.97	57.4625	70.26	negligible
R15	141	141	6	7.5	97.99	122.4875	270.9875	emergency
S1	10.95	14.6	NIL	0	39.94	133.1333	147.7333	alert
S2	45.6	60.8	7.3	24.333333	207.11	690.3667	775.5	significant harm
S3	130.45	173.9333	12.94	43.133333	48.98	163.2667	380.3333	significant harm
S4	87.15	116.2	21.96	73.2	209.28	697.6	887	significant harm
S5	40.62	54.16	3.8	12.666667	937.25	3124.167	3190.993	significant harm
S6	4.48	5.973333	3.42	11.4	54.33	181.1	198.4733	alert

Data Source: Chattopadhyay, S., et. al., 2010

Table 6.National noise level standards

Category of area	Limit in dB	
	day time (6 am to 9 pm)	night time (9 pm to 6 am)
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silence zone	50	40

Source: Santra, S.C., 2006

aquifer appears at the depth range varying between 7.4 m and 36.6 m below ground level (b.g.l.) with variable thickness of the aquifer from 6 m to 10 m. The second aquifer having thickness varying between 34 m and 79 m occur at the depth range of 19.3 m to 109 m b.g.l. Now the question is that in collaboration with urbanization is the ground water remained as safe limit or below critical limits? So to judge it the quality assessment is completed below on the basis of water quality standard of Schedule of the Environmental Protection Rules, 1989 and IS 10500: 1991 (Table 2). The pH value of ground water ranges from 6.31 to 9.55. Bicarbonate values of ground water samples are within desired limit for domestic use.

Table 7.Noise level variations from different locations of Barddhaman town at different interval (2005)

Sl. No.	Location [1]	Noise Level in dB (measured in 2004)											
		6:00 AM		10:00 AM		1:00 PM		4:00 PM		6:00 PM		Avg.	Avg.
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Near Vidyarthi Girls High School	64	80	65	86	65	85	66	87	64	83	64.8	84.2
2	Municipal Boys High School (G.T. Road)	66	85	73	93	72	92	73	92	70	92	70.8	90.8
3	Near C.M.S. High School (B.C. Road)	72	84	78	93	74	88	76	87	79	92	75.8	88.8
4	Near M.U.C. Women's College	78	86	77	91	76	87	75	88	77	89	76.6	88.2
5	Near Hospital Main gate	65	75	70	82	68	80	70	81	70	81	68.6	79.8
6	Burdwan University First gate	60	71	65	75	63	80	66	80	62	74	63.2	76
7	Curzon gate	69	84	78	95	74	89	61	82	79	95	72.2	89
8	Station Choumatha	69	87	75	90	74	92	76	95	80	94	74.8	91.6
9	B.C. road (near Anita Cinema)	70	83	70	89	70	88	71	87	71	85	70.4	86.4
10	Raniganj Bazar Choumatha	72	82	77	94	74	84	75	85	78	91	75.2	87.2
11	Tinkonia Bus Stand	73	87	77	97	77	91	77	93	79	94	76.6	92.4
12	Near Rajbati	68	81	74	86	72	82	72	85	77	89	72.6	84.6
13	Telipukur More	72	96	85	102	74	98	72	95	73	94	75.2	97
14	Parbirhata more	71	91	76	97	72	88	73	90	69	86	72.2	90.4
15	Vivekanada College More	69	92	79	97	72	88	73	90	69	86	72.4	90.6
16	On the Railway over bridge of Barddhaman town	72	93	76	97	74	97	75	96	77	95	74.8	95.6
17	Golapbag more	75	86	76	92	74	90	73	94	73	94	74.2	91.2

Note: Sl. No. 1-6 SILENCE ZONE, Sl. No. 7-10 COMMERCIAL ZONE and Sl. No. 11-17 OTHERS AND HEAVY TRAFFIC AREAS **Data Source:** Dutta, J.K., et.al., 2005

Table 8.Present Environmental pollution scenario of Barddhaman town (2011)

Types and sources of pollution	Affected wards
Drain water stagnation	1,2,3,8,9,10,11,16,17,31
Solid waste and garbage	1,2,3,4,5,6,7,8,10,11,12,13,16,17,19,22,23,24,27,28,31,32,33,34,35
Industrial pollution	13,14,15,16,17,18,19,21,22,25,26,35
Wetland encroachment and surface water pollution	14,16,17,24,26,27
Air pollution	3,5,7,9,18,19,20,21,22,23,25,31,32,33
Noise Pollution	3,7,9,15,31,32,33,34

Maximum concentration of sulphate (53 ppm) and potassium (38 ppm) are found in Alamganj. Average Total Hardness (as $CaCO_3$) of confined aquifer is 201.4 ppm which is also within permissible limit (600 ppm). The most critical factor is that the mean value of total is 1.51 ppm which lies beyond desirable limit (0.3 ppm) of drinking water. The analysis revels that except deficiency of Fluorine, high content of iron and moderate to very high hardness at many places, the overall chemical quality of ground water is as per the norms of BIS:10500. Density of the ponds is more in the northern parts of the town as compared to the southern parts which is due to the different geological formations present in these areas. Now, to judge the suitability of surface water following chemical analysis has been done for few selected samples. Alongside, bottom sediment samples of ponds and rivers were collected by Geological Survey of India to know the actual concentration of heavy metals like Zn, Cu, Pb, Co, Ni, Cd, Cr and Mn (figure 4). In addition concentrations of fluoride and arsenic were also determined. The major closed water bodies include Krishnasyar, Syamsyar, Ranisyar, Kamalsyar, Sulipukur, Pirpukur and 108 Sibmandir. The rivers include Damodar, Banka and Sapjala. The quality assessment is completed below on the basis of water quality standard of Schedule of the Environmental Protection Rules, 1989 and IS 10500: 1991 (Table 3). Sewage, other organic wastes, animal and human extract are classified as oxygen demanding waste. The depletion of O_2 acts as a stress factor for aquatic organisms, particularly fish. Nitrite, nitrate and phosphate increase the eutrophication process of rivers, drains and water-bodies (Dash, 2001). Total Coliform and fecal Coliform amount is exceeded than maximum limit in selected water samples of WBPCB. Except Mn, Fe and Al, all the trace

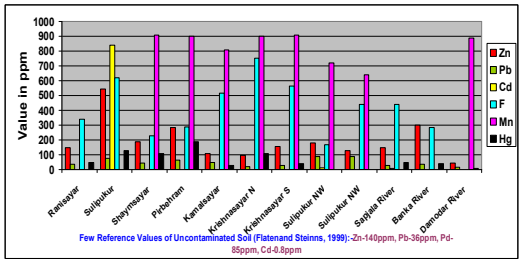


Figure 4.Trace element analysis of bottom sediment samples of ponds and rivers (Data source-GSI, 2005)

elements are within the desirable limit in the samples of surface water bodies. Ponds like Krishnasayar, Shyamsayar and Sadhanpur have high alkanity (pH: 9.07-9.18). Water samples of Banka, Sapjala and Damodar rivers reveal that the water has high concentration of Fe, Al and Mn. But bottom sediment analysis gives crucial information about the unwanted concentration of heavy metals. Ranisayar, Sulipukur, Shyamsayar, Pirbeharam, Krishnasayar, Sapjala and Banka rivers have high content of Zn (15-545 ppm) than the critical limit of 140 ppm. In some parts of Sulipukur have high concnetartion of Pd (75-9 ppm). The table shows that almost all the samples reveal that there are high content of Cd (>0.8 ppm) in bottom sediments of ponds and rivers.

Assessing the Seasonal Air Quality

Air pollution may be defined as any atmospheric condition in which certain substances are present in such concentration that they can produce undesirable effects on man and his

environment (Rana, 2007). Barddhaman, being a busy town of increased population pressure, is nearest to Durgapur (70 km) is the 7th polluted city in India and air pollutants have the capacity to travel a long distance. The quality of ambient air deserved systematic as well as scientific investigations so that a proper spatial expansion of pollutants or pollution can be found. That's why pre-monsoon and post-monsoon concentration data of selected air pollutants i.e. SO_2, NO_2 and Respiratory Suspended Particulate Matter (RSPM) are collected. This analysis performs a GIS based air pollution surface model on the basis of air quality index. Altogether data of 25 selected locations of Barddhaman (location categorization as per Central Pollution Control Board: residential area-R, industrial area-I and sensitive area-S) are selected for this study (Table 4 and Figure 5). Ott (1978) developed a common 'Pollutant Standard Index' (PSI) for United States. The PSI is established by defining an index value of 100 as the equivalent of the short-term (24 hour or less) national, primary ambient air quality standards. These short-term primary standards represent the concentration below which adverse health effects have not been observed, thus PSI is based on health effects (Carry, 1993). The procedure is to calculate a simple ratio sub-index value for the three pollutants. The sub-index is calculated as follows: Sun-index$_i$ = concentration of pollutants . (100) / short-term primary standard

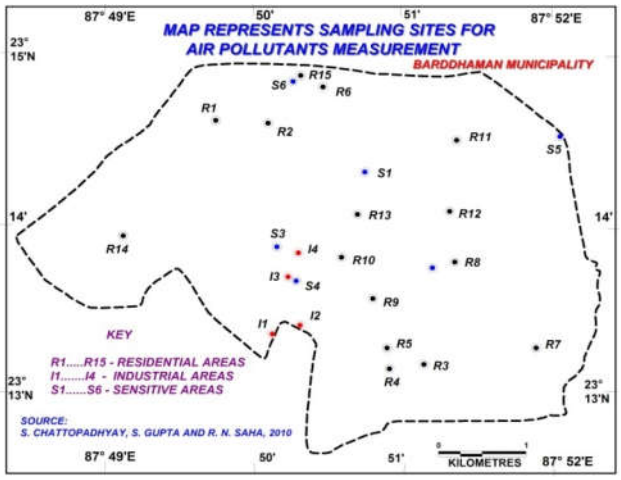
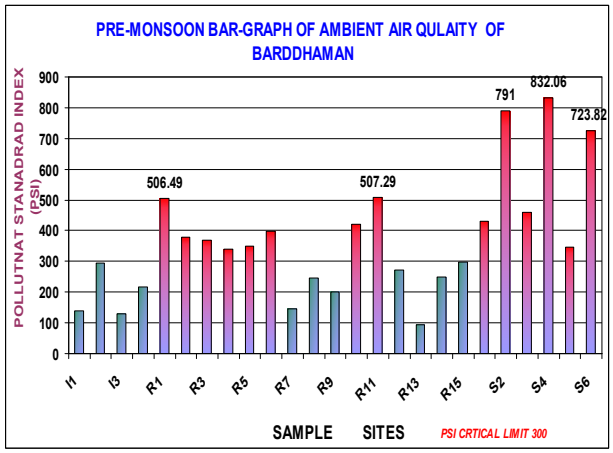
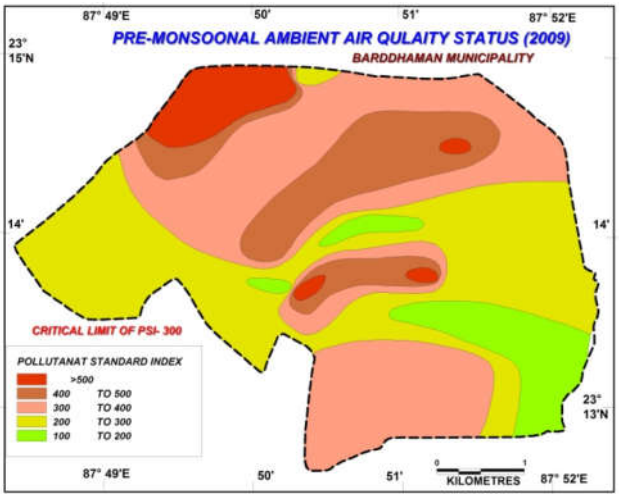


Figure 5.Sample locations of air quality measurements.
Data Source: Chattopadhyay, S., et. al., 2010



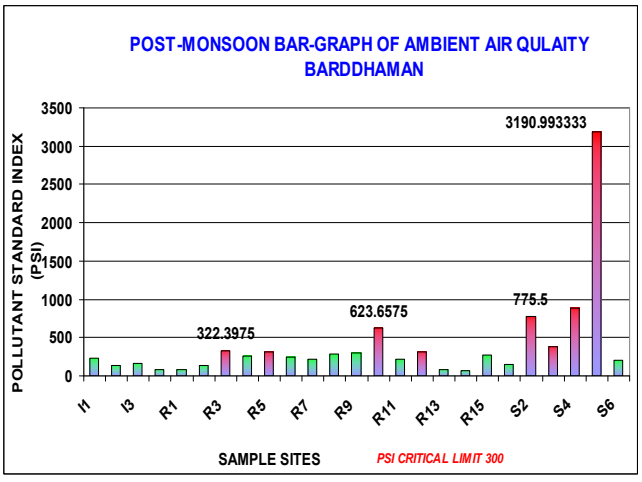
(a)



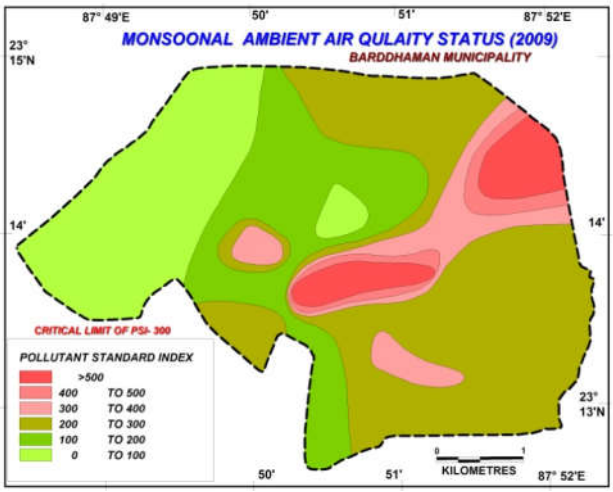
(b)

Figure 6.Pre-Monsoonal air quality status: (a) graphical analysis of PSI of selected locations and (b) spatial coverage of different classes of PSI.

The pollution data (table 5) was collected in the months of March, April and May (summer season). During this time all the industrial sites have high level of RSPM than the standard limit (150 microgram/ m^3). This might be due to resuspension of road dust, soil dust and vehicular traffic and nearby industrial emission. Except R7, R13 and R15, RSPM level is exceeded its standard in all residential sites. Regarding sensitive sites except sites S5 and S6 most of the RSPM values is recorded as above the limit of standard (75 microgram/m^3). Maximum RSPM level is found in S4 site (363.6 microgram/m^3). All total maximum SO_2 level is observed in R1 site, near Bypass road of Nawabhat (238 microgram/m^3).sensitive sites of high traffic density have generated high level of NO_2 than limit (30 microgram/m^3). R1, R2, R3, R5, R6, R7, R10, R11, S1, S2, S3, S4, S5 and S6 sites are demarcated as highly harmful air pollution sites on the basis of PSI (>300). The western parts of wards 25, 26 and 1 and 18, 19, 20, 34, 35, 2, 3 and 7 numbered wards have PSI value of greater than 400. In this time south-western parts and eastern parts of the town have safe air quality in respect of others. From the thematic map it has been discovered that 7.47 km^2 of area is affected by acute air pollution in pre-monsoon (Figure 6).



(a)



(b)

Figure 7.Monsoonal air quality status: (a) graphical analysis of PSI of selected locations and (b) spatial coverage of different classes of PSI

The pollution data (Table 6) was collected in the months of June, July, August and September (rainy season). In general it is found that RSPM concentration is significantly less than the pre-monsoon concentration except site R15. This phenomenon might be corroborated to monsoonal wash out of the particles. In sites of S3 and S4 the post-monsoon RSPM level exceeds the standard limit (75 microgram/m^3). This might be due to their locational disadvantages as because both these two places are located in the region of rice mills. Among industrial, residential sites has higher level of SO_2 than others. Maximum monsoonal concentration of NO_2 is observed in R10 site (426.28 microgram/m^3). Except R1, R11, R13 and R14 sites, other residential sites have shown higher level of NO_2 than the limit (80 microgram/m^3). From the analysis of PSI (>300) it is cleared that R3, R5, R10, R10, S2, S3, S4, S5 and S6 sites have experienced significant harmful air pollutants in monsoonal period. Ward number 6, 7, 14, 15, 18, 19, 20, 21, 22, 31, 33 and 35 have Psi value of greater than 300, which signify the environmental risk in terms of air pollution. The ward number 35 has faced worst situation (PSI - 3191) among other wards due to high traffic density. Only western portion of the town has secure air quality in monsoon. From the map it has been discovered that 2.73 km^2 area is affected by acute air pollution in monsoon (Figure 7). The investigations of GSI (2003-05) revealed that the concentration of RSPM and SPM (Suspended Particulate Matter) was much higher than standard limit in Raniganj Bazar (RSPM- 122.6µg/m^3 and SPM- 225.3 µg/m^3). The RSPM and SPM recorded at Barddhaman Municipal High Scholl (Boys) are 85.9-97.3 µg/m^3 and 121.7-201.6 µg/m^3 respectively which exceeded the limit of 100µg/m3 of air stipulated for sensitive areas. The similar observation is observed at Barddhaman Hospital. However, on closed market day of Raniganj Bazar, the RSPM and SPM concentration of same station of Raniganj Bazar shows remarkable decline of SPM (92.4 µg/m^3). Higher concentration of NO_x above the stipulated tolerance limit of 30 µg/m^3 of air was recorded at the stations like vicinity of Star cinema hall, Barddhaman Municipal High Scholl (Boys), Hospital, Sarbamangal Temple and Swami Debananda Ashram. It is real fact that the rice mills (operating at night also) of Kamnara, Alamganj and Tejganj areas have released an alarming quality of RSPM and SPM into the atmosphere.

Noise Pollution Status

Sound is a form of energy, consisting of wave motion. The apparent noise that is perceived by human ear depends on both the frequency and intensity of sound. The term 'noise' is applied to the sound that causes irritation on hearing of healthy human being (Santra, 2006). Barddhaman town is not an industrial area; therefore, noise mainly arises from the transportation system. Various types of vehicle, automobile, cycle, rickshaw etc. create tremendous noise at various points of Barddhaman. There is a close positive correlation between traffic congestion and noise level. Since it is a district administrative headquarter with many offices and working places noise pollution gets its maximum level at office hours. For monitoring noise level seventeen different important nodal locations of the town are selected on the basis of zone specific. According to Environmental Protection Rules, 1986 (Schedule-III) in respect of noise, most of these locations are in the category of commercial zone, silence zone and heavy traffic zones (Table 6 and Figure 8).

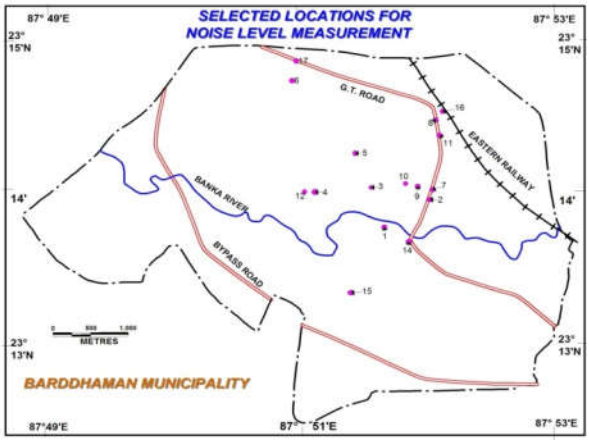


Figure 8.Selected location for noise level measurements

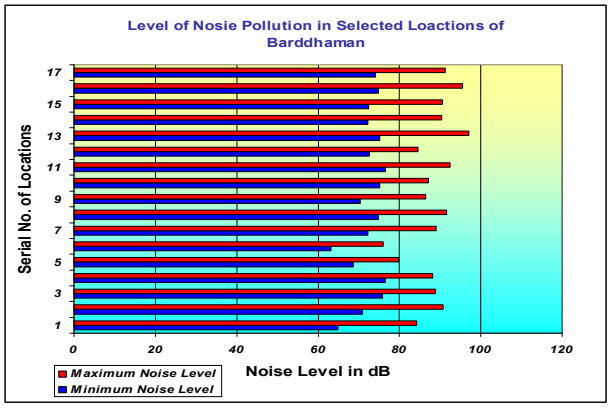


Figure 9.Graphical analysis of average noise level of selected locations (2004)

'Silence Zone' is defined as an area comprising not less than 100 metre around hospitals, educational institutions and courts. On the basis of table, we can say that all the schools,

first gate of University of Burdwan, Women's college and hospital main gate are suffered from moderate to heavy noise in day time (6 am-6 pm). The selected locations of 7-10 (commercial areas) are witnessed heavy noise in working hours (table 7 and figure 9). Alongside noise pollution is observed in the 11-17 locations with heavy traffic areas. Since the monitoring was performed in summer season noise level at 1 pm, was very much lower than the data of 10 am and 6 pm. All total, each location has crossed the permissible noise level in day time. Geological Survey of India of Eastern Region (2003-2005) made an assessment report on noise pollution of the town. Both the day time noise level (61.70-70.40 dB) and the night time noise level (58.78-61.33 dB) recorded in Barddhaman Municipality High School (Boys) have exceeded the corresponding tolerance limits stipulated i.e. (50 dB) and (40 dB) respectively. The noise level measured at Barddhaman Hospital is (68.85-78.17 dB) during day time and (60.34-65.66 dB) during night time. The places like Burdwan Hospital, Kalibazar, Ranjganj Bazar, Barddhaman C.M.S. High School (Day) and Barddhaman Municipal High School (Boys), have crossed the specified limit of MOEF (Ministry of Environment and Forest, 2005) (>61.07 dB at day and >58.78 dB at night).

Pollution Risk Zonation of Barddhaman

All of three pollutions' status are analysed quantitatively and we have been understood the degree of environmental risk. So providing a composite map of pollution risk, it is quite helpful to get an idea about the ward-wise pollution status and cautions to be taken. Gathering the spatial information of Air-Water-Noise pollutions and other types of pollution, perception survey and ground observations we have been scored each ward in terms of magnitude of pollution level, viz. 5-very high, 4-high, 3-moderate, 2-low and 1-very low pollution risk. After getting the total scored value out of twenty five score, we have been categorised thirty five wards into highly pollution risk, moderately pollution risk and low pollution risk regions (figure 10). The ward getting greater than fifteen score is recognized as high magnitude of pollution risk ward. The final map shows that densely populated and centrally located wards are more exposes to all type of pollution risk, specially air and noise pollution. But nine wards of western and south eastern parts (ward no. 23, 24, 25, 26, 27 and 28) have very low amount of pollution risk, having greater vegetation cover and less dense population (Table 8 and Figure 10).

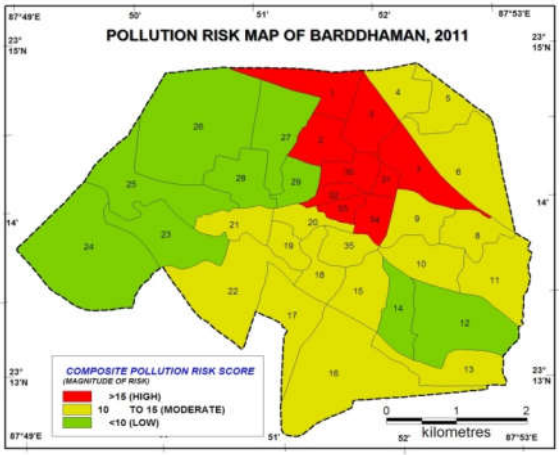


Figure 10.Ward-wise pollution risk map of Barddhaman town

Conclusion

We have been obtained successful results employing the methodology for this study. The measurements, collected data, quantitative results, graphs and thematic maps have clearly shown that Barddhaman town has numerous glimpses of pollutions. The most critical condition is observed in the pre-Monsoon and Monsoonal air quality. A medical record of Barddhaman Municipality was revealed that 'in 2008 two hundred twenty nine people were suffered from the respiratory diseases, out of which nineteen people are died in that year'. The main culprits are unaccountable vehicles, rice mills and brick kiln industries. The nodal busy points and dense residential areas of the town are very much suffered from air pollution. Again, inevitably the expansion of residential areas and markets pollute the surface waterbodies (mainly Banka River) in terms of throwing garbage and occupying the area. Surprisingly the concentration of Fe, Cd and Mn are high in some ponds. The important fact is that there is a probability of ground water shortage in coming future due to its unchecked population growth. Increasing urbanization and urban congestion are very much responsible for noise pollution in the silence zones. Considering the results of study and survey, the 'pollution risk map' provides the ultimate picture of the town where eight important densely populated wards are suffered from high level of different kinds of pollution risk.
Therefore, the above analysis reveals that Barddhaman Municipality does not maintain its former healthy environment due to unavoidable anthropogenic activities and improper treatment of pollution and waste. So the hypothesis regarding glimpses of pollution is a ground reality and the specific areas have suffered from specific types of pollution. The urbanization and developmental processes of Barddhaman Municipality should now transfer its focus on maintaining the healthy physical environment, taking environmental impact assessment of pollution related anthropogenic activities. We have learnt that nature can be conquered carries within it seed of human destruction. The onus of adaptation lies on the human society and not on nature.

REFERENCES

Bhattacharya, A.K. and Dhar, N. 2005. *A report on Geo-Environmental Appraisal in Barddhaman Urban Agglomeration area and its Environment for Sustainable Development Activities*, Eastern region of Geological Survey of India (GSI), Kolkata

Canter, L. W. 1996. *Environmental Impact Assessment*, McGraw Hill, New York

Chattopadhyay, S., et.al. 2010. *Spatial and TemporalVariation of Urban Air Quality: A GIS Approach*, http//:SciRP.org /journal/jep, accessed on 14th April, 2011, 12:37 pm

Dash, M.C. 2001. *Fundamentals of Ecology*, Tata McGraw Hill, New Delhi

Datta, J.K., et.al. 2006. *Assessment of Noise Level in Burdwan Town, West Bengal*, http//:jeb.co.in/journal_ issuses/ 2000607_jul06/paper_pdf, accessed on 7th April, 2011, 11:45 pm

Khopkar, S.M. 1998. *Environmental Pollution Analysis*, New Age International, New Delhi

Konar, G. 2010. *Barddhaman Samagra* (ed.), Dey Book Store, Kolkata

Manivaskam, N. 1984. *Environmental Pollution*, National Book Trust, New Delhi

Marsh, W.M. and Grossa, J.M. 1996. *Environmental Geography: Science, Land Use and Erath Systems*, Jhon Wiley and Sons, New York

Mondal, N.K., et.al. 2011. *A comparative Assessment of Status of Indoor Air Pollution of Few Selected families of Rural and Urban area of Burdwan Town and Its adjoining area*, http//:ipublishing.co.in/jesvol1no12010/EIJES2029.pdf, accessed on 19th April, 2011, 14:12 pm

Mukherjee, S. and Ghosh, A 2000. *Environmental Studies*, Books and Allied Ltd, Calcutta

Rana, S.V.S. 2007. *Environmental Pollution: Health and Toxicology*, Narosa publishing house, New Delhi

Santra, S.C. 2006. *Environmental Sciences*, New Central Book Agency, Kolkata

Strahler, A.N. 1977. *Man and its Environment*, John Wiley and Sons, New York

Vink, A.P.A. 1983. *Landscape Ecology and Land Use*, Logman, London

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