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Research article

PHYSICOCHEMICAL ANALYSIS OF GROUND WATER NEAR MUNICIPAL SOLID WASTE DUMPING SITE IN BHUBANESWAR MUNICIPAL CORPORATION, ODISHA

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ABSTRACT: The capital city of Odisha known as Bhubaneswar is under the administration of Bhubaneswar Municipal Corporation (BMC). Because of rapid urbanization the population of BMC has grown manifold during the last decade. As a result of the increasing population load, the requirement of water has also increased considerably. Due to various human activities, a huge amount of municipal solid waste is generated which are dumped in different dumping sites of BMC. Infiltration of water by rainfall, water already present in the waste, water generated by biodegradation cause the leachate to leave the dumping ground and percolate into the ground water thereby causing contamination. Presently around forty percent of people of BMC depend on ground water which is getting polluted day by day. In view of this it is felt necessary to make an evaluation of the status of ground water quality in BMC. Eight different locations near Municipal Solid Waste Dumping Site have been chosen spreading across Bhubaneswar Municipal Corporation. The samples were collected yearly in 2009 – 10 and 2010 – 11 to determine the physical, chemical and biological parameters. Attempt has been made to see the impact of dumping of Municipal Solid Waste on the ground water due to non-scientific disposal as at present. From the study of physicochemical parameters along with heavy metal concentration of the tube well placed near the dumping site for the year 2009–2010, it was found that presently almost all the parameters are within the limit for drinking water in both the years except Iron and Turbidity. But all the parameters are in increasing trend over the years which is clearly indicated in the graph. So it is the high time to take preventive action to arrest the leaching from the municipal dumping site to ground water otherwise ground water of Bhubaneswar will become unfit for drinking purpose within a very short period of time.

Key Words: Municipal Solid Waste, Ground Water Quality, Location Points, Leachates

INTRODUCTION

Bhubaneswar is the capital city of Odisha. From a small village in and around Lord Lingaraj Temple, it has grown into a Municipal Corporation consisting of 47 wards and a population about 10 lakhs. On account of rapid urbanization, the population of the city has increased manifold and there has been a rapid growth in terms of huge building and apartments, hotels and restaurants, hospitals and technical institutions, transportation and vehicles etc. Consequently the requirement of water has also been constantly increasing. Municipal Solid Waste is a growing problem in modern times. Increase of population and rapid growth of urbanization have resulted in generation of huge quantity of Municipal Solid Waste which is usually dumped in the open dumping sites. Waste materials of the leachates so formed during the course of time may percolate to the ground water table. Leachates are formed by slow decomposition of municipal solid waste. MSW Leachate contains variety of chemicals like detergents, inorganic chemicals and organic chemicals and metals. These components are themselves very much toxic and pose a great threat to the human environment. During infiltration of water by rainfall, water already present in the waste of water generated by biodegradation cause the leachates to leave the dumping ground laterally or vertically and finds its way to the ground water thereby causing contamination [2]. The leachates when mixed with water body increase the concentration of heavy metals, nitrates, sulfates and other organic and inorganic substances. The impact of leachate on ground water and other water resources has an overwhelming environmental significance. Leachate migration from waste sites or landfills and the release of pollutants from sediments pose a high risk to the ground water resource. [5].

Therefore, the present study deals with the assessment of ground water quality near municipal solid waste dumping site in BMC in order to understand the level of pollution so that appropriate measures could be taken to make the ground water pollution free. [4].

MATERIAL AND METHODS

In order to evaluate the water quality and physiochemical characteristics of ground water 08 different sampling locations near municipal solid waste dumping site were chosen in Bhubaneswar Municipal Corporation. The details of the location of the sampling points are described in Table-A.

The water samples were collected from each location on yearly basis in 2009 – 10 and 2010 – 11. The samples were collected in plastic and glass bottles as per requirement. Different physical, chemical and biological parameters such as pH, Conductivity, Total Hardness, Calcium Hardness, Magnesium Hardness, Iron, Sulfate, Fluoride, Turbidity, Nickel, Zinc, Lead, Copper, Cadmium of these samples were analyzed in the laboratory by following procedure as given in Table-B. The analysis was done by following Analysis of Water and Waste Water, 20th Edition, APHA-2005. All chemicals and reagents were of analytical reagent grade. [8,10].

RESULT AND DISCUSSION

pH

The pH value ranges from 5.9. mg / l to 7.3 mg / l in 2009 and from 6.0 mg / l to 7.1 mg / l in 2010. From the yearly variation it is observed that in all the locations pH value is within the permissible limit i.e. 6.5 mg / l to 8.5 mg / l except in m-4 and m-8.

Conductivity

The conductivity value ranges from 188.4 μΩ / cm to 372.0 μΩ / cm in 2009 and from 209.6 μΩ / cm to 411.0 μΩ / cm in 2010. From the yearly variation it is observed that the conductivity value in all the locations except in m-5 is within the permissible limit i.e. 400 μΩ / cm. The high content of conductivity at m-5 may be due to the presence of high chloride content.

Total Hardness

The TH value ranges from 72.0 mg / l to 148.2 mg / l in 2009 and from 84.0 mg / l to 172.0 mg / l in 2010. From the yearly variation it is observed that the TH content in all the location is within the desirable limit i.e. 300 mg / l.

Calcium Hardness

The CaH value ranges from 48.0 mg / l to 104 mg / l in 2009 and from 56.0 mg / l to 118 mg / l in 2010. From the yearly observation it is observed that the CaH content in all the locations is below the permissible limit i.e. 200 mg/ l.

Magnesium Hardness

The MgH value ranges from 24.0 mg / l to 44.6 mg / l in 2009 and from 28.0 mg / l to 54.0 mg / l in 2010. From the yearly observation it is observed that the MgH content in all the locations is within the permissible limit i.e.100mg/ l.

Iron

The Iron value ranges from 2.2 mg / l to 4.2 mg / l in 2009 and from 2.4 mg / l to 4.4 mg / l in 2010. From the yearly variation it is observed that in all the locations the iron content does not meet the prescribed standards i.e. 0.3 mg/l. The high iron content in the ground water near the dumping site may be attributed due to laterite soil and the leaching effect of the municipal solid waste of the dumping site.

Sulphate

The Sulphate value ranges from 4.2 mg / l to 9.5 mg / l in 2009 and from 4.8 mg /l to 10.2 mg / l in 2010. From the yearly variation it is observed that the sulphate content far below the prescribed limit.

Fluoride

The Fluoride content in different locations ranges from 0.38 mg / l to 0.64 mg/l in 2009 and from 0.44 mg / l to 0.84 mg / l in 2010. From the yearly variation it is observed that in all the locations the fluoride content is within the prescribed standard i.e. 1.0 mg / l.

Turbidity

The Turbidity value in different locations ranges from 9.6 NTU to 32.8 NTU in 2009 and from 10.8 NTU to 34.6 NTU in 2010. From the yearly variation it is observed that the turbidity value in all the locations is much higher than the prescribed limit i.e. 10 NTU. This may be attributed due to the leaching effect of the municipal solid waste near the dumping site as well as the presence of high content of iron.

Nickel

The Nickel content in different locations ranges from 0.012 mg / l to 0.04 mg/l in 2009 and from 0.014 mg / l to 0.076 mg / l in 2010. From the yearly variation it is observed that the nickel content is below the prescribed limit which may be due to leaching effect of the municipal solid waste near dumping site.

Zinc

The Zinc content in different locations ranges from 0.048 mg / l to 0.16 mg/l in 2009 and from 0.054 mg / l to 0.18 mg / l in 2010. From the yearly variation it is observed that in all the locations the zinc content is within the prescribed standard i.e. 5 mg / l but it is in increasing trend which may be attributed to the impact of municipal solid waste near dumping site.

Lead

The Lead content in different locations ranges from 0.044 mg / l to 0.21 mg/l in 2009 and from 0.058 mg / l to 0.22 mg / l in 2010. From the yearly variation it is observed that in four location points i.e. m-3, m-4, m-5 and m-6 the lead content is more than the prescribed standard i.e. 0.05 mg / l but in the rest of the locations, it is within the standard value. However, the lead content is in increasing trend which may be due to the leaching effect of municipal solid waste.

Table : A: Location points of Ground Water near Municipal Solid Waste Dumping Site.

S. No.	Location of Sampling Points	Code No.
1	Jharapada (Behind Jharpada U.P. School in Ward No.22)	M – 1
2	Badagada (Behind Badagada High School in Ward No. 39)	M – 2
3	Anna House Chhaka (On the Mahatab Road between Temple Chhak to Pokhariput Level Crossing in Ward No.44)	M – 3
4	Salia Sahi (Diagonally opposite to Women's Poly Technique along the road leading to Maitri Bihar) Ward No.9)	M – 4
5	Behind Kanchanjunga Apartment (Behind Kanchanjunga Mult-storied apartment in Ward No.4)	M – 5
6	Behind Rajdhani College (By the side of Indian Air Force Office and Rajdhani College in Ward No.15)	M – 6
7	Dumduma (By the side of the road that leads to Dumduma Housing Board Colony in Ward No.33)	M – 7
8	Mali Sahi (Behind Sriya – Stutee Talkies and Garden Inn Hotel in Ward No.25)	M – 8

Table–B: Method of Analysis of different parameters

S. No.	Parameters	Unit	Method of Analysis
1	pH	-	pH meter
2	Conductivity	$\pi\Omega$/cm	Conductivity meter
3	Total Hardness	mg/l	Titroimetric method by using E DTA
4	Calcium Hardness	mg/l	Titrimetric Method
5	Magnesium Hardness	mg/l	By difference of TH & Calt
6	Iron	mg/l	1,10 Phenanthroline Colorimetric method
7	Sulfate	mg/l	Spectrophotometer
8	Fluoride	mg/l	Iron selective electrode method
9	Turbidity	NTU	Nephlo Turbidity Meter
10	Nickel	mg/l	Acid digestion followed by AAS
11	Zinc	mg/l	Acid digestion followed by AAS
12	Lead	mg/l	Acid digestion followed by AAS
13	Copper	mg/l	Acid digestion followed by AAS
14	Cadmium	mg/l	Acid digestion followed by AAS

AAS = Atomic Absorption Spectrophotometer

Copper

The Copper content in different locations ranges from 0.007 mg / l to 0.06 mg/l in 2009 and from 0.009 mg / l to 0.074 mg / l in 2010. From the yearly variation it is observed that the copper content in most of the locations except at m-4, m-7 and m-8 where it is slightly higher than the prescribed value (i.e. 0.05 mg / l). However, the Copper content is found to be in increasing trend which may be due to the impact of municipal solid waste near the dumping site.

Cadmium

The cadmium content in different locations ranges from 0.004 mg / l to 0.01 mg / l in 2009 and 0.005 mg / l to 0.016 mg / l in 2010. From the yearly variation it is observed that the cadmium content at m-3, m-6 and m-7 is more than the prescribed limit i.e. 0.03 mg / l. However, it is also observed that the cadmium value is in increasing trend which may be attributed to the proximity of municipal solid waste near the dumping site.

Table -C: IS 10500: 1991 Test Characteristics for Drinking Water

S. No	Substance of Characteristic with unit	Desirable Unit	Permissible Limit
1	pH	6.5 to 8.5	No relaxation
2	Conductivity (μΩ/cm)	400 at 20º C	2500 at 20º C
3	Total Hardness (mg/l)	300	600
4	Calcium (mg/l)	75	200
5	Magnesium (mg/l)	30	100
6	Iron (mg/l)	0.3	1.0
7	Sulfate (mg/l)	200	400
8	Fluoride (mg/l)	1.0	1.5
9	Turbidity NTU	5.0	10.0
10	Nickel (mg/l)	0.1	0.1
11	Zinc (mg/l)	5	15.0
12	Lead (mg/l)	0.05	No relaxation
13	Copper (mg/l)	0.05	1.5
14	Cadmium (mg/l)	0.01	No relaxation

Yearly Variations of Physicochemical Characteristics of the Ground Water near Dumping Sites in Bhubaneswar Municipal Corporation, Odisha for the year 2009 and 2010.

Table–1: pH

S. No.	Location of the sampling points	pH 2009	pH 2010
1	Jharpada	6.7	6.8
2	Baragarh	7.3	7.1
3	Anne house chhaka	6.6	6.5
4	Salia Sahi	6.0	6.2
5	Behind Kanchanjanga Apartment, C.S. Pur	6.7	6.4
6	Behind Rajdhani College	7.0	7.3
7	Dumduma	6.4	6.6
8	Mali Sahi	5.9	6.0

Table–2: Conductivity

S. No.	Location of the sampling points	Cond. (μΩ/cm) 2009	Cond. (μΩ/cm) 2010
1	Jharpada	284.2	292.6
2	Baragarh	304.6	352.2
3	Anne house chhaka	328.0	332.0
4	Salia Sahi	322.4	360.0
5	Behind Kanchanjanga Apartment, C.S. Pur	372.0	411.0
6	Behind Rajdhani College	188.4	209.6
7	Dumduma	232.6	252.8
8	Mali Sahi	230.0	264.0

Table–3: Total Hardness

S. No.	Location of the sampling points	TH (mg/l) 2009	TH (mg/l) 2010
1	Jharpada	72.0	84.0
2	Baragarh	88.0	106.0
3	Anne house chhaka	92.4	109.0
4	Salia Sahi	82.6	88.0
5	Behind Kanchanjanga Apartment, C.S. Pur	148.2	172.0
6	Behind Rajdhani College	100.0	112.0
7	Dumduma	112.6	136.0
8	Mali Sahi	110.0	122.0

Table–4: Calcium Hardness

S. No.	Location of the sampling points	CaH (mg/l) 2009	CaH (mg/l) 2010
1	Jharpada	48	56
2	Baragarh	54	68
3	Anne house chhaka	64	72
4	Salia Sahi	52	60
5	Behind Kanchanjanga Apartment, C.S. Pur	104	118
6	Behind Rajdhani College	72	80
7	Dumduma	68	78
8	Mali Sahi	62	70

Table–5: Magnesium Hardness

S. No.	Location of the sampling points	MgH (mg/l) 2009	MgH (mg/l) 2010
1	Jharpada	24	28
2	Baragarh	34	38
3	Anne house chhaka	28.4	37
4	Salia Sahi	30.6	28
5	Behind Kanchanjanga Apartment, C.S. Pur	44.2	54
6	Behind Rajdhani College	28	32
7	Dumduma	44.6	58
8	Mali Sahi	48	52

Table–6: Iron

S. No.	Location of the sampling points	Iron (mg/l) 2009	Iron (mg/l) 2010
1	Jharpada	4.2	3.8
2	Baragarh	2.6	2.4
3	Anne house chhaka	3.8	4.2
4	Salia Sahi	3.2	3.6
5	Behind Kanchanjanga Apartment, C.S. Pur	4	4.4
6	Behind Rajdhani College	2.2	2.8
7	Dumduma	3	3.4
8	Mali Sahi	2.6	2.9

Table–7: Sulfate

S.No	Location of the sampling points	$SO4^{2-}$ (mg/I)	$SO4^{2-}$ (mg/I)
		2009	2010
1	Jharpada	6.4	7.0
2	Baragarh	7.8	8.4
3	Anne house chhaka	5.6	6.2
4	Salia Sahi	4.2	4.8
5	Behind Kanchanjanga Apartment, C.S. Pur	5.0	5.6
6	Behind Rajdhani College	4.6	4.9
7	Dumduma	8.0	8.4
8	Mali Sahi	9.5	10.2

Table–8: Fluoride

S. No.	Location of the sampling points	F^- (mg/I)	F^- (mg/I)
		2009	2010
1	Jharpada	0.46	0.58
2	Baragarh	0.48	0.69
3	Anne house chhaka	0.66	0.74
4	Salia Sahi	0.38	0.44
5	Behind Kanchanjanga Apartment, C.S. Pur	0.44	0.59
6	Behind Rajdhani College	0.62	0.68
7	Dumduma	0.38	0.52
8	Mali Sahi	0.64	0.84

Table–9: Turbidity

S. No	Location of the sampling points	Turb (NTU)	Turb (NTU)
		2009	2010
1	Jharpada	14.8	15.9
2	Baragarh	9.6	10.8
3	Anne house chhaka	12.8	14.2
4	Salia Sahi	32.8	34.6
5	Behind Kanchanjanga Apartment, C.S. Pur	24.6	26.8
6	Behind Rajdhani College	10.5	11.4
7	Dumduma	24.4	26.8
8	Mali Sahi	32.6	38.4

Table–10: Nickel

S. No	Location of the sampling points	Ni (mg/l)	Ni (mg/l)
		2009	2010
1	Jharpada	0.012	0.014
2	Baragarh	0.05	0.058
3	Anne house chhaka	0.066	0.076
4	Salia Sahi	0.018	0.022
5	Behind Kanchanjanga Apartment, C.S. Pur	0.028	0.039
6	Behind Rajdhani College	0.04	0.048
7	Dumduma	0.022	0.032
8	Mali Sahi	0.038	0.044

Table–11: Zinc

S.No	Location of the sampling points	Zn (mg/l) 2009	Zn (mg/l) 2010
1	Jharpada	0.078	0.094
2	Baragarh	0.055	0.064
3	Anne house chhaka	0.06	0.072
4	Salia Sahi	0.16	0.18
5	Behind Kanchanjanga Apartment, C.S. Pur	0.068	0.088
6	Behind Rajdhani College	0.07	0.076
7	Dumduma	0.048	0.054
8	Mali Sahi	0.08	0.092

Table–12: Lead

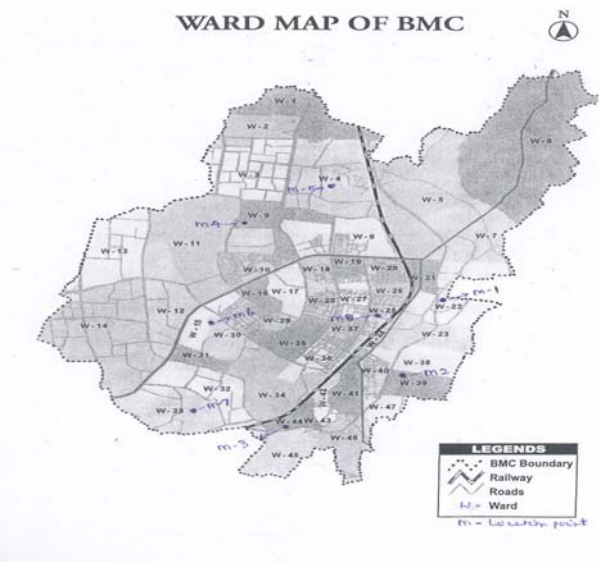
S. No.	Location of the sampling points	Pb (mg/l) 2009	Pb (mg/l) 2010
1	Jharpada	0.058	0.064
2	Baragarh	0.072	0.078
3	Anne house chhaka	0.08	0.098
4	Salia Sahi	0.06	0.068
5	Behind Kanchanjanga Apartment, C.S. Pur	0.12	0.14
6	Behind Rajdhani College	0.21	0.22
7	Dumduma	0.068	0.074
8	Mali Sahi	0.044	0.058

Table–13: Copper

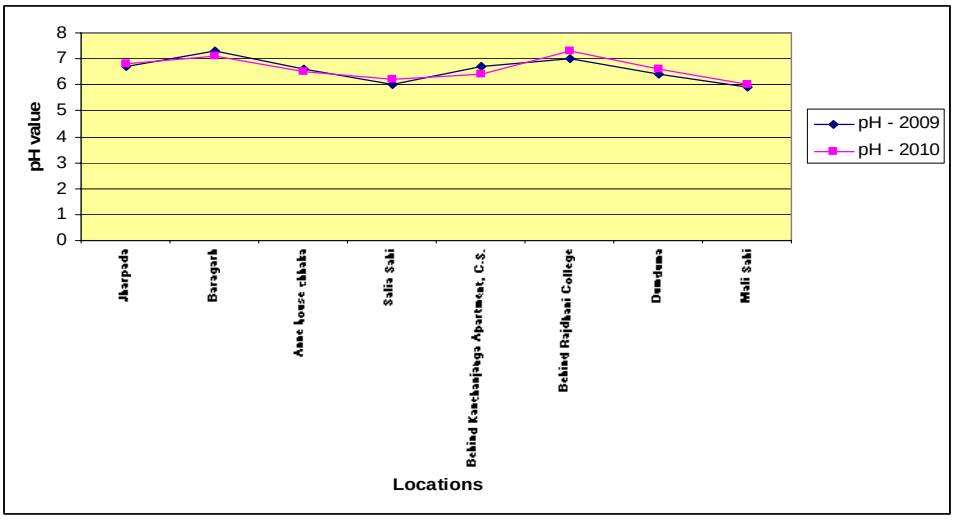
S.No	Location of the sampling points	Cu (mg/l) 2009	Cu (mg/l) 2010
1	Jharpada	0.007	0.009
2	Baragarh	0.014	0.016
3	Anne house chhaka	0.027	0.029
4	Salia Sahi	0.064	0.074
5	Behind Kanchanjanga Apartment, C.S. Pur	0.026	0.033
6	Behind Rajdhani College	0.022	0.028
7	Dumduma	0.06	0.068
8	Mali Sahi	0.044	0.054

Table –14: Cadmium

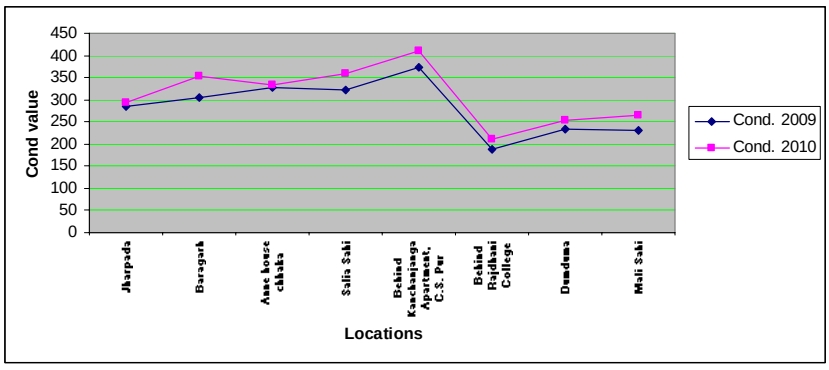
S.No	Location of the sampling points	Cd (mg/l) 2009	Cd (mg/l) 2010
1	Jharpada	0.006	0.008
2	Baragarh	0.006	0.006
3	Anne house chhaka	0.01	0.012
4	Salia Sahi	0.007	0.008
5	Behind Kanchanjanga Apartment, C.S. Pur	0.006	0.007
6	Behind Rajdhani College	0.014	0.016
7	Dumduma	0.012	0.014
8	Mali Sahi	0.004	0.005



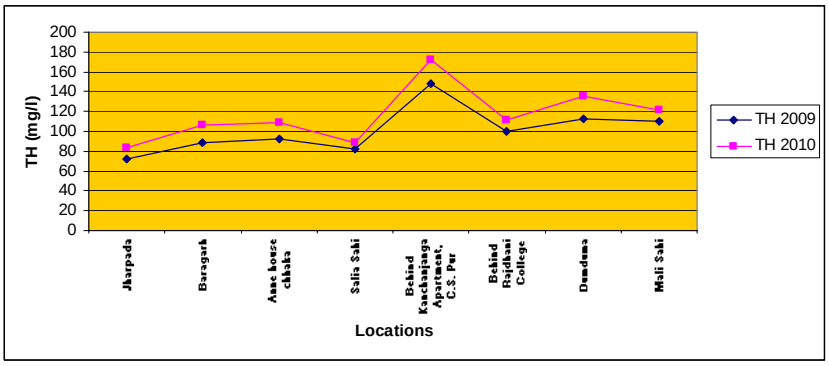
Linear graph of Yearly Variations of Ground Water near Dumping Site in Bhubaneswar Municipal Corporation, Odisha for the year 2009 and 2010.



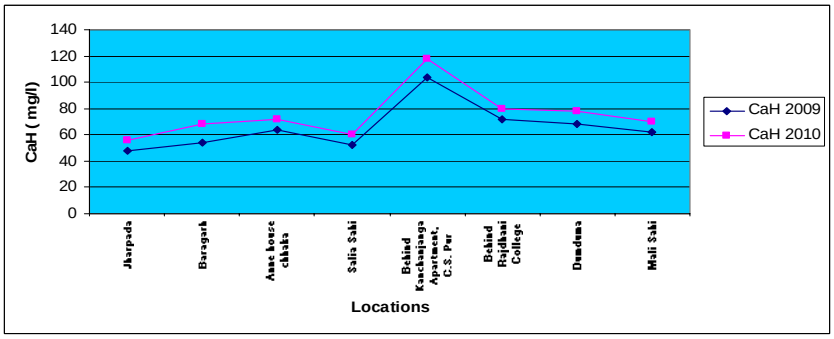
Figure–1: pH



Figure–2: Conductivity



Figure–3: Total Hardness



Figure–4: CaH

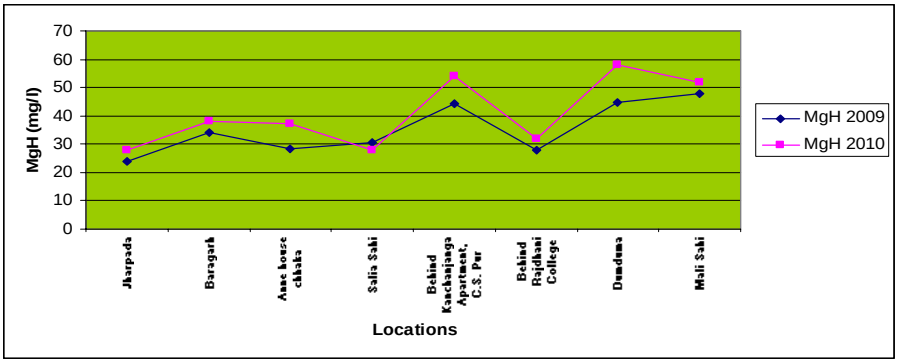
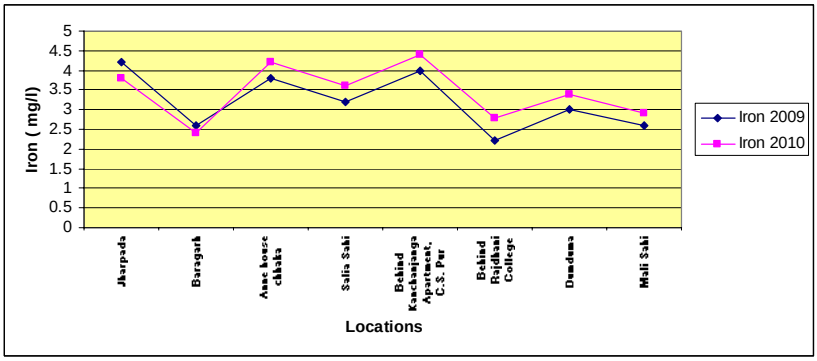
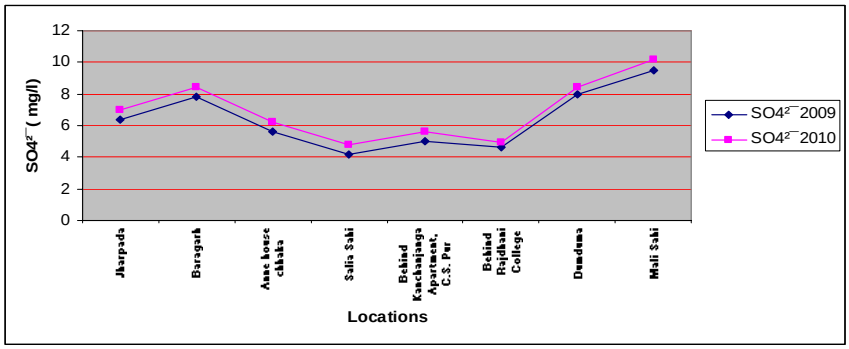


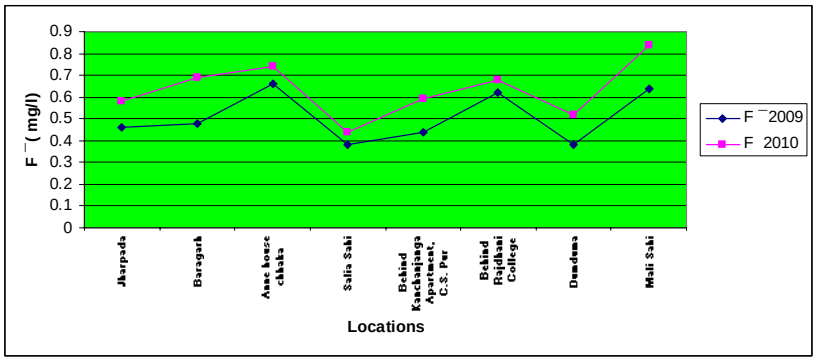
Figure-5: MgH



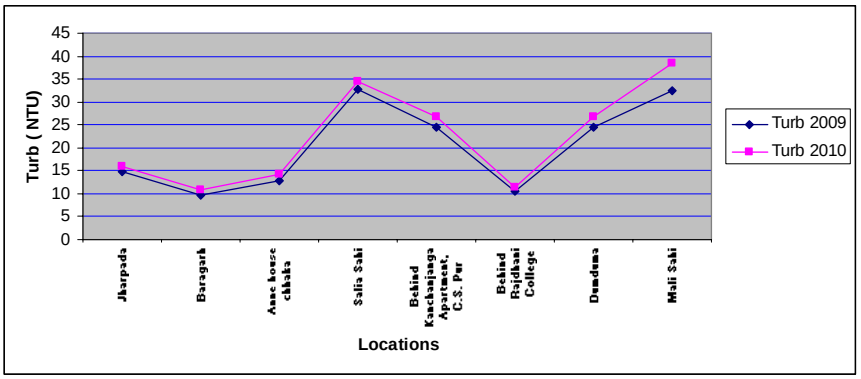
Figure–6: Iron



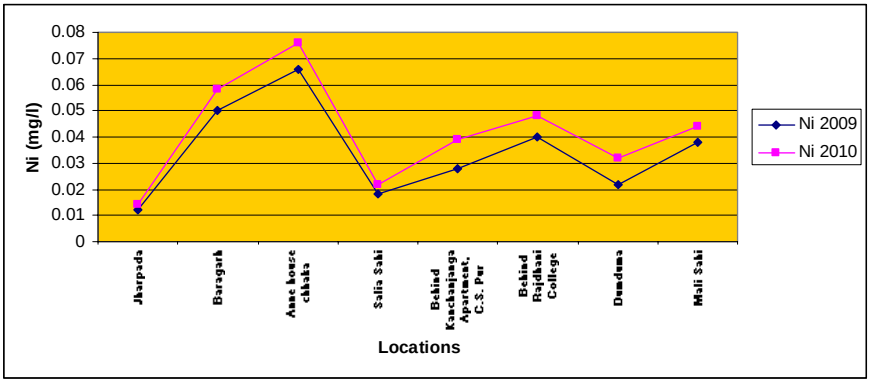
Figure–7: Sulfate



Figure–8: Fluoride



Figure–9: Turbidity



Figure–10: Nickel

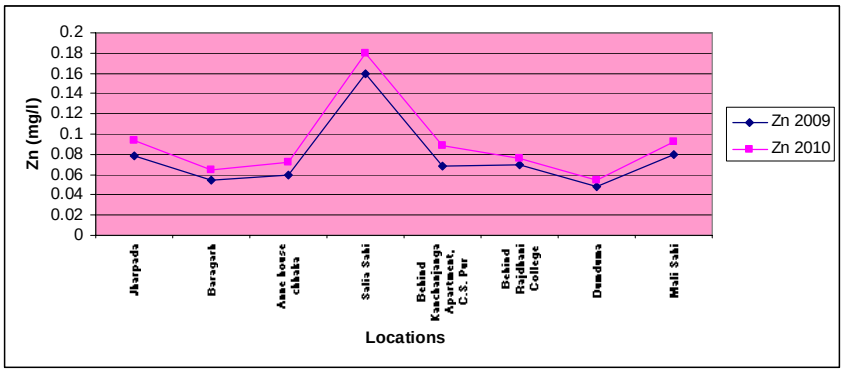


Figure-11: Zinc

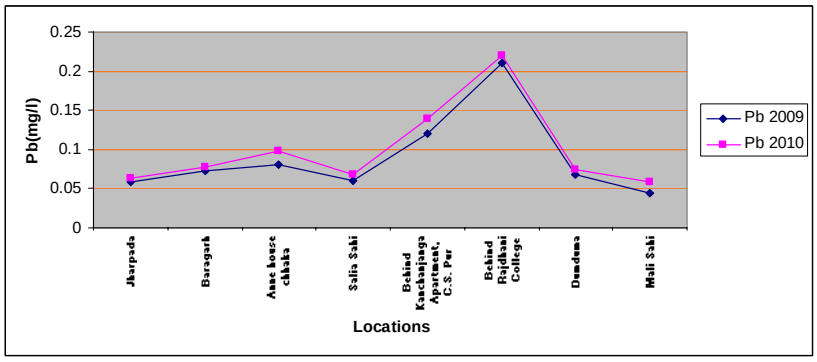
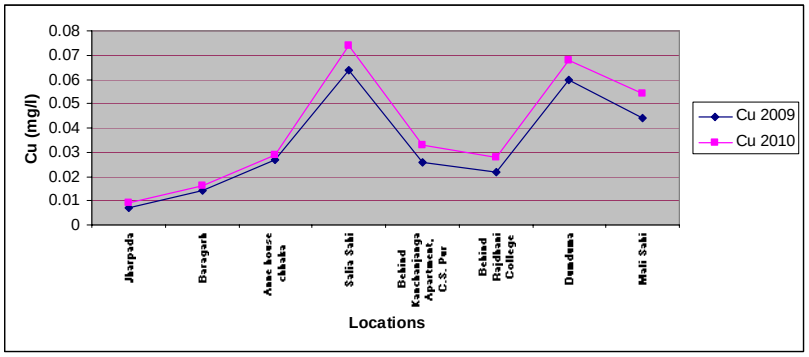
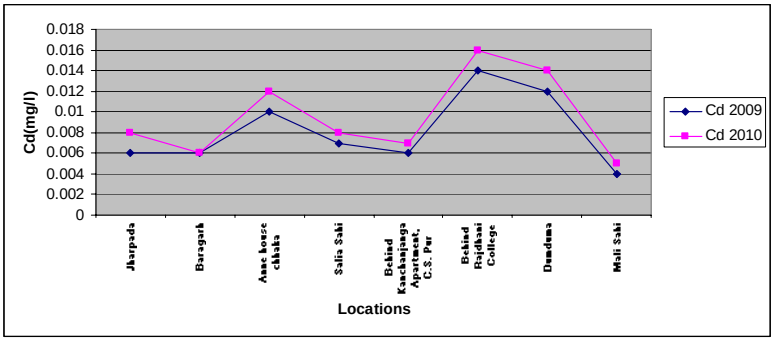


Figure – 12: Lead



Figure–13: Copper



Figure–14: Cadmium

CONCLUSION AND RECOMMENDATION

01. From the above study it is revealed that the value of iron and turbidity is found in higher range in most of the locations which may be due to leaching of toxic substances of municipal solid waste into the ground water table. [9]. The leachates formed slowly percolate into the ground water and contaminate the water thus making it unfit for drinking. The above results indicate the impact of the dumping of municipal solid waste in the study area as the ground water is slowly getting polluted.
02. It is further observed during the study period that the contents of trace metals are found in increasing trend which indicates that the ground water is slowly getting contaminated. Hence urgent measures need to be taken to arrest the metal contamination of ground water table.
03. The indiscriminate dumping of municipal solid waste in the dumping site has a significant impact on the ground water leading to pollution of drinking water. Hence appropriate measures need to be taken by civic authorities to develop a proper solid waste management by making a secure landfill with concrete lining followed by high density polythene to prevent any type of percolating contact on ground water.

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