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IMPACT ON GROUND WATER QUALITY AROUND WASTE DISPOSAL SITE IN SOUTHERN PART OF PATNA URBAN

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Abstract: The quality of ground water is of great importance in determining its suitability for certain uses (public water supply, irrigation, industrial applications, power generation etc.). A major problem in urban area is the collection and disposal of domestic wastes. Because a large volume of sewage is generated in a small area, the waste cannot be adequately disposed-off by conventional septic tanks and cesspools. Therefore, special disposal sites are being used to collect and dispose such wastes in densely populated areas.
To study the ground water quality near waste dumping sites, data[1] of a total number of eleven water samples from waste disposal sites in southern part of Patna urban confined along bypass road towards Fathua, were utilized.
The geochemical classification of ground water in the study area reveals that 63.6 % of the water samples are associated with temporary hardness and exhibit Calcium-Magnesium-bicarbonate type water where as only 36.4 % show Calcium-Magnesium-Chloride type water associated with permanent hardness. High correlation between various chemical indices shows that potassium increases with nitrate and sodium increases with chloride in the study area which may be due to run off water from agricultural fields where fertilizers are used or dumping of household garbage. Also sodium increases with chloride in the study area which may be due to ingress of saline water into ground water due to increasing ground water withdrawals along the coasts of the river. With increase in bicarbonate concentration, sodium, magnesium & chloride also increases considerably which may be attributed to the dumping of domestic waste and waste water containing soaps and detergents etc. The source of pollution seems to be mostly anthropogenic in nature and can be minimized by proper treatment and disposal of waste.
Keywords: Geochemical classification, Chemical indices, Correlation, Anthropogenic

INTRODUCTION

In recent years, an increasing threat to ground water quality due to human activities has become of great importance. The adverse effects on ground water quality are the results of man's activity at ground surface, unintentionally by agriculture, domestic and industrial effluents, unexpectedly by sub-surface or surface disposal of sewage and industrial wastes. The quality of ground water is of great importance in determining the suitability of particular ground water for a certain use (public water supply, irrigation, industrial applications, power

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generation etc.). It is the resultant of all the processes and reactions that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged by a well. A major problem in urban area is the collection and disposal of domestic wastes. Because a large volume of sewage is generated in a small area, the waste cannot be adequately disposed - off by conventional septic tanks and cesspools. Therefore, special disposal sites are being used to collect and dispose such wastes in densely populated areas. The intensive use of natural resources and the large production of wastes in modern society often pose a threat to ground water quality and have already resulted in many incidents of ground water contamination. Pollutants are being added to the ground water system through human activities and natural processes. Solid waste from industrial units is being dumped near the factories, which is subjected to reaction with percolating rain water and reaches the ground water level. The percolating water picks up a large amount of dissolved constituents and reaches the aquifer system and contaminates the ground water.

The water used for drinking purpose should be free from any toxic elements, living and nonliving organism and excessive amount of minerals that may be hazardous to health. Some of the heavy metals are extremely essential to humans, for example, cobalt, copper, etc., but large quantities of them may cause physiological disorders. The contamination of ground water by heavy metals and pesticides has also assumed great significance during recent years due to their toxicity and accumulative behavior. These elements, contrary to most pollutants, are not biodegradable and undergo a global eco-biological cycle in which natural waters are the main pathways.

Consequence to the observance of the chemical data from waste disposal sites in southern part of Patna urban confined along bypass road towards Fathua an attempt has been made to interpret the water quality of the area in terms of its geochemical classification and also study the correlation between various chemical indices to know the source of pollution in ground water.

HYDROGEOLOGY OF THE AREA

Patna town, the capital of Bihar has got glowing historical past, being capital of Great Magadh Empire during the reign of 'Ashoka the Great'. It had been a centre of trade, seat of education and rich cultural heritage. The metropolitan city is located at 25°22'12" N latitude and 85°7'48" E longitude. The total geographical area of the city is 125 km^2. The river Punpun forms south of township limit and river Ganga it's Northern limit. The Eastern boundary of township is partly bounded with Ganga and partly with river Punpun. The Patna

Canal forms its Western limit. It is 14th largest town in India (population wise), and the first in the state of Bihar. As per census, 2001, the population of Patna metropolitan city is 17,07,429. The township and surrounding is underlain by thick fuvial sediments deposited by the river Ganga and its right bank tributaries, Sone and Punpun. Basically the deposits belong to Quaternary period and are flood plain deposits. The sediments are admixture of clay and sand of different grades.

PHYSIOGRAPHY AND DRAINAGE

Physiographically, the township lies between the Doab region of river Punpun and Ganga, a part of which is, flood prone. This urban conglomerate falls in eastern part of Ganga plain and has got a monotonous relief with numerous localize low lying patches which occasionally gets filled in forming a pool of water during the rainy season. The river Punpun flowing south of Patna and Sone flowing west of Patna overflood their bank during monsoon season, while during lean period gets dried up indicating thereby their influent character and possible high recharge to deeper aquifer.

CLIMATE

The climate of Patna town is of tropical type and is characterized by three distinct seasons. Climatologically parameter of the township indicates that mean maximum temperature is 31.6 °C varying between 23.6°C in January to 38.9°C in the month of May while the night temperature varies between 11ºC to 27.1ºC with mean annual value of 20.8 °C. The relative humidity is comparatively higher over the year ranging between 41% to 83% lowest being in the month of April. The bulk of the annual rainfall (1109.8mm) is received through South Western monsoon during the period of June to September.

GROUND WATER POTENTIAL

Patna city, lying in the alluvium formation has two major potential aquifer systems. The first shallow aquifer within depth of 50 m is constituted of fine sandy horizon and second aquifer lies at depth below 50 m to 70 m is of medium to coarse sand. The aquifer geometry indicates presence of clay layer at the top ranging in thickness between 30 m to 50 m, below which main potential is present consistently over the entire area. The ground water of shallow aquifer in the area occurs under unconfined state while deeper aquifer occur under semi confined to confined state.

RESULTS AND DISCUSSION

Fig-1, below depicts the location sites of 11 water samples around waste disposal sites in southern part of Patna urban confined along bypass road towards Fathua. The minimum, maximum and average values of different chemical parameters are summarized in Table-I.

FIGURE - 1

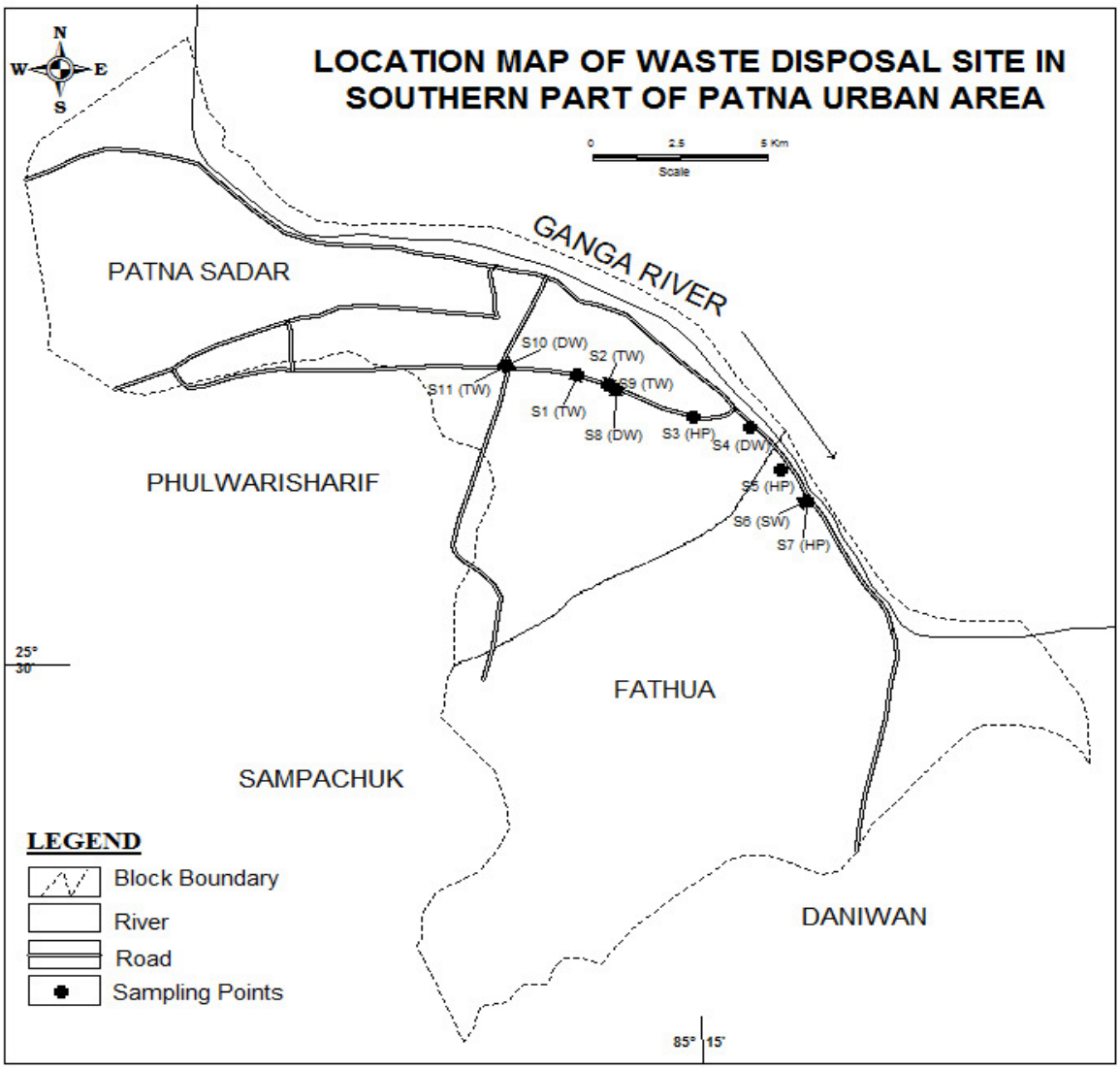


TABLE I: Hydro-Chemical Data of Ground Water around Waste Disposal Site

S. No.	Constituents	Minimum	Maximum	Average
1.	pH	6.96	8.21	7.31
2.	Electrical Conductance (EC) µS/cm at	355	2760	1027
3.	Carbonate (CO_3) mg/l	nil	Nil	Nil
4.	Bicarbonate(HCO_3) mg/l	195	1049	453
5.	Chloride (Cl) mg/l	11	178	66
6.	Total Hardness (as $CaCO_3$) mg/l	140	605	311
7.	Calcium (Ca) mg/l	24	108	58
8.	Magnesium (Mg) mg/l	12	124	43
9	Nitrate (NO_3) mg/l	3.4	48	19
10.	Sulphate (SO_4) mg/l	5.8	69	44
11.	Fluoride (F) mg/l	0.32	1.48	0.84
12.	Silica (SiO_2) mg/l	3.4	22	15
13.	Sodium (Na) mg/l	22	180	66
14.	Potassium (K) mg/l	1.2	165	31
15.	Copper (Cu) µg/l	19	26	22
16.	Iron (Fe) µg/l	162	502	281
17.	Manganese (Mn) µg/l	36	1030	219
18.	Zinc (Zn) µg/l	62	798	296

Systematic study of the chemical data for 11 numbers of water samples reveals that the ground water is mildly alkaline in nature. Ground water in the study area is found to be fresh except from a dug well near National Institute of Health Education, Bari Pahari which is associated with EC value of 2760µS/cm at 25 ºC. The total hardness in dug well near National Institute of Health Education, Bari Pahari is found to be associated with undesirable Mg hardness (Mg -124 mg/l). High bicarbonate alkalinity (HCO_3 -1049 mg/l) is also observed in the same well water. This dug well water is mostly used for washing clothes, bathing etc. As the lining of the well is worn off, so it is quite possible that the waste water carrying detergent, soap seepages into the well itself, making its water unsuitable for drinking.

The nitrate concentration in two water sample from H.P., in Umesh Rai's House, Fajampur (NO_3 – 46 mg/l) & T.W., Sita Ram's house, near Devi Sthan mandir, Bari Pahari (NO_3 – 48

mg/l) are found to be beyond the permissible limit [2]. These high values may be due to anthropogenic activities of man.

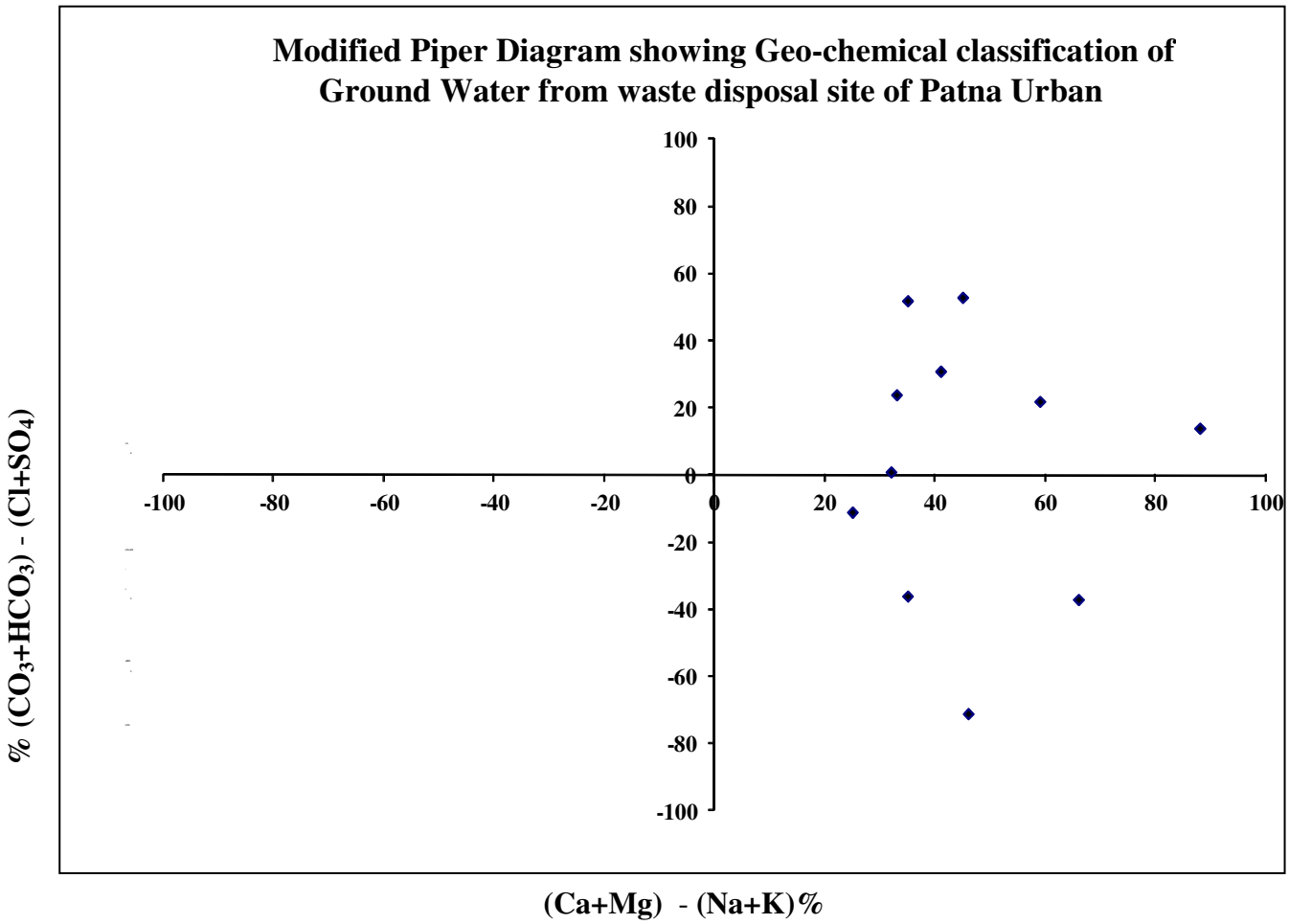
High values of potassium > 10 mg/l are observed at three places 21 mg/l (D.W., Green City Nursery, Dhabalpura), 34 mg/l (T.W., Godown Falcon Tyre Ltd., R.H.S. road towards Fathua) and 165 mg/l (D.W., near National Instt. Of Health Edu., Bari Pahari). A nala flows nearby green city nursery and a pond nearby. In the dry season it becomes the dumping site of waste vegetation, household waste etc. During rainy season, high values K may be due to leaching, in the area. Moreover, human activities also add to the anomalous values of these constituents by using manures and fertilizers to their gardens or fields in excess.

High values of Iron > 300 µg/l are observed at three places viz. 318 µg/l (D.W., near National Instt. of Health Edu., Bari Pahari), 471 µg/l (Ganga R., Kachi Dargah Ghat) & 502 µg/l (H.P., in Umesh Rai's House, Fajampur). Such waters are associated with undesirable taste and has adverse effect on domestic uses and water supply structures and promotes bacteria hence is unfit for potable purposes.

High values of Manganese > 100 µg/l are observed at two places viz. 201 µg/l (D.W., Green City Nursery, Dhabalpur) & 1030 µg/l (D.W., near National Instt. Of Health Edu., Bari Pahari). Such water are associated with undesirable taste and has adverse effect on domestic uses and water supply structures.

The geochemical classification of ground water reveals that 63.6 % of the water samples are associated with temporary hardness and exhibit Ca-Mg-HCO_3 type water where as only 36.4 % show Ca-Mg-Cl type water associated with permanent hardness as is clear from Fig- 2, modified Piper Diagram[3].

FIGURE - 2



An attempt has also been made to study the correlation between various chemical indices by evaluating the correlation coefficients as tabulated in Table - II.

TABLE II: Correlation Coefficient (r) among Chemical Indices

Chemical Indices	**Ca**	**Mg**	**Na**	**K**	**HCO_3**
HCO_3	- 0.05	0.85	0.87	0.05	-
Cl	0.19	0.74	1.0	0.26	0.87
NO_3	0.32	0.10	0.26	1.0	0.05
F	-0.13	-0.13	0.54	0.53	0.54

It is evident from Table- II, that there exists a very strong correlation between Na & Cl and K & NO_3 with (r = 1.0). Strong correlation also exists between HCO_3 & Cl and HCO_3 & Na

with (r = 0.87). Also Mg & HCO_3 and Mg & Cl are strongly correlated with (r = 0.85 and 0.74) respectively. High correlation is also observed F & HCO3 and F & Na with (r = 0.54) and also between F & K with (r = 0.53). Low negative correlation is observed between F & Ca and F & Mg with (r = -0.13).

Thus, it shows that potassium increases with nitrate in the area and sodium increases with chloride in the study area which may be due to run off water from agricultural fields where fertilizers are used or dumping of household garbage etc.

High value of (r) between HCO_3 & Na, HCO_3 & Mg, HCO3 & F and HCO_3 & Cl shows that with increase in HCO_3 concentration, Na, Mg, F & Cl also increase considerably which may be attributed to the dumping of domestic waste and waste water containing soaps and detergents etc.

Thus, it can be very well said that the ground water quality of waste disposal site in urban area is affected mainly due to anthropogenic activity.

CONCLUSION

The ground water of the study area is found to be mildly alkaline in nature and mostly fresh. Only the dug well water near National Institute of Health Education, Bari Pahari is associated with high values of EC, T.H., Mg & HCO_3 alkalinity as this dug well water is mostly used for washing clothes, bathing etc. The lining of the well is worn off, so it is quite possible that the waste water carrying detergent, soap seepages into the well itself, making its water unsuitable for drinking.

High values of K > 10 mg/l are observed at three places & high values of NO_3 are observed at two places. These anomalous values associated with ground water may be due to leaching of waste vegetation, household waste etc. which is dumped during dry season in a nearby pond. Moreover, human activities also add to the anomalous values of these constituents by using manures and fertilizers to their gardens or fields in excess.

High values of Fe > 300 µg/l are observed at three places & high values of Mn > 100 µg/l are observed at two places. Such waters are associated with undesirable taste and has adverse effect on domestic uses and water supply structures and promotes bacteria hence is unfit for potable purposes.

The geochemical classification of ground water in the study area reveals that 63.6 % of the water samples are associated with temporary hardness and exhibit Ca-Mg-HCO_3 type water where as only 36.4 % show Ca-Mg-Cl type water associated with permanent hardness. High

correlation coefficient ($r > 0.5$) between various chemical indices may be attributed to the dumping of domestic waste and waste water containing soaps and detergents etc.

Thus, it can be very well said that the ground water quality of waste disposal site in southern part of Patna urban along bypass road towards Fathua at a few sites has some constituents above the permissible limit which renders the water unfit for human consumption. The source of pollution is mostly anthropogenic in nature and can be minimized by proper treatment and disposal of waste.

RECOMMENDATIONS

The ground water quality of waste disposal site in southern part of Patna urban along bypass road towards Fathua at a few sites has some constituents above the permissible limit which renders the water unfit for human consumption. These sources should be avoided for potable purposes as these may cause health hazard.

REFERENCES

[1] Neelam Nigam (2013): Ground Water Quality of Waste Disposal Site in Southern Part of Patna Urban- Govt. of India, Ministry of Water Resources, C.G.W.B., Mid-Eastern Region, Patna, Special Study Technical Report.

[2] B.I.S. (2012): Indian Standard Specifications for drinking water, I.S. 10500.

[3] D.K. Chadha (1998): A new Diagram for Geochemical Classification of Natural Waters and Interpretation of Chemical Data, Bhu-Jal News, Vol.13, No. 1 & 2 , pp 1– 4.