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"Effect Of Polluted Surface Water On Groundwater: A Case Study Of Budha Nullah"

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***Abstract**: Groundwater is one of the most important natural resources. It is a major source of fresh drinking water in both the rural and urban regions. The groundwater quality, however in recent time has got deteriorated due to the percolation of polluted water in to the soils from the wastewater drains, polluted rivers and ponds. As a result its quality has not remained potable in many parts of the country. Contaminated groundwater of Mettupalayam Taluk in Tamil Nadu, Amravati River Basin of Karur District, Tamil Nadu, Eastern Uttar Pradesh are some of the example. Therefore, the evaluation of water quality of the rivers, groundwater and impact of polluted groundwater on environment and health has drawn attention of the researchers. The present thesis is also an attempt on such study. The pollution level of Budha Nullah water and its effect on groundwater and vicinity area have been studied in the present paper. Total eleven groundwater samples, seven Budha Nullah samples and five soil samples were collected from different locations within 6 km stretch of Budha Nullah and its adjoining areas. The samples of the different points were collected from handpumps and tubewells, the water from which is used for drinking and other purposes.*

All the quality parameters of these samples were analyzed using standard methods prescribed in "Standard methods for examination of water and wastewater" (18TH edition). It was observed that pH of all the collected samples was within permissible limit of 6.5-8.5. The surface water analysis of Budha Nullah reveals high values of Total Dissolved solids up to 1642 mg/L, chlorides up to 400 mg/L, Chemical Oxygen Demand values up to 448mg/L, Biochemical Oxygen Demand varying between 52-195 mg/L, Most Potable Number varying from 240+ upto 2400+ per 100ml, heavy metal like Cr in the Budha Nullah has value 0.031 mg/L, Fe 0.913 mg/L, Mn 0.043 mg/L and Ni 0.222 mg/L. The quality of ground water at many places was found to be unfit for drinking mainly due to high amount of total dissolved solids and most potable number being much higher than the prescribed limit as per ISO 10500 standards. SAR of soil ranges from 3.78 to 6.98 mg/kg, which is optimum value for soil, as soils with SAR value less than 10 are considered good for leaching and water percolation. The reason behind the presence of other form of impurities and heavy metals in the ground water could be due to presence of heavy metals in surface water of Budha Nullah and its seepage in the adjacent groundwater aquifers.

Objectives Of Study:

The rapid industrialization in Ludhiana, though contributed to economic development, has resulted in heavy losses to economic welfare in terms of effects on agricultural activities, human health and ecosystem at large through air and water pollution. Solid and liquid wastes emanating from the industrial activities are the inevitable by-products of manufacturing process. These wastes contain toxic chemicals such as Chromium salts, sulfides and other substances including heavy toxic trace metals. These materials enter the surface water and subsurface aquifers resulting in water pollution. The town which earned the name of Manchester of Punjab landed into dubious distinction of being one of the most polluted human settlements in the country (G.S Gill et al.,1997). Similarly industries located in Mettupalayam taluk, Tamilnadu dispose their effluents on land, and the farmers of the adjacent farmlands have complained that their shallow open wells get polluted and also the salt content of soil has started building up slowly. Study found that continuous disposal of industrial effluents on land, which has limited capacity to assimilate the pollution load, has led to groundwater pollution (Mukherjee *at el.*, 2006).

In this dissertation an attempt has been made to study the water quality of the Budha Nullah and groundwater. Grab sampling was done from the different locations through the 12 km stretch of Budha Nullah in the Ludhiana city .

The Main Objectives Of The Study Are :

1) To analyze the physico-chemical parameters, biological parameters.
2) To examine Heavy metal in the surface and groundwater samples.
3) To examine heavy metals in the soil samples

Significance Of The Study:

Water is an absolute necessity for life. Water bodies may host harmful biological and chemical agents that impact the health of the humans. There exist a strong correlation between waterborne biological agents and human disease. In my study, various physico-chemical, biological and heavy metal analysis studies are done to check the groundwater and surface quality and analysis of heavy metals in soils is done. For effective protection, setting of abatement strategy and successive revitalization of ecosystems it is necessary to know the ecological quality of surface and groundwater. Protecting of water resources is of paramount importance thus assessing the water quality after regular intervals is necessary for the decision makers to take remedial actions and to solve the problem well in time.

I. Introduction

Groundwater is one of the prime sources of fresh water. It is an important source of drinking water for the world's population. In 21st century our natural water resources have been used unconsciously which leads to it's over exploitation. Water pollution is increasing steadily due to rapid population growth, industrial proliferations, urbanizations, increasing living standards and wide spheres of human activities.

Ground water contamination is generally irreversible i.e. once it is contaminated; it is difficult to restore the original water quality of the aquifer. Excessive mineralization of groundwater degrades its quality and produces an objectionable taste, odour and excessive hardness. Although the soil mantle through which water passes acts as an adsorbent retaining a large part of colloidal and soluble ions with its cation exchange capacity, but ground water is not completely free from the menace of chronic pollution. Therefore, it is always better to protect ground water in the first place rather than relying on technology to clean up contaminated water at a later stage.

India is developing country which means infrastructure sector is growing on at a much higher rate, leads to the development of core industries like metals, chemicals, fertilizers, drugs and petroleum etc and other industries such as plastics, pesticides, detergents, solvents, paints, dyes, and food disposed their effluents and emissions on land and water bodies and polluting our environment. The disposal of solid and liquid wastes containing heavy metals like lead, nickel, chromium, molybdenum, and mercury in to the ecosystem, leads to heavy metal contamination of our natural habitat (i.e. soil, water and air ecosystems).

Budha Nullah:

It runs parallel to Sutlej, on its south for fairly large section of its course in the district and ultimately joins Sutlej at Gorsian Kadar Baksh in the north western corner of the district. Ludhiana and Machhiwara are situated to the south of the Budha Nullah. The water of the stream becomes polluted after it enters Ludhiana City. With the industrialization/ urbanization of the area, Budha Nullah has become the sullage/ sewage as well as industrial effluent carrier for the Ludhiana city leading to River Sutlej.

II. Materials And Method

Location of sampling source:

Water samples were collected from Budha Nullah and its vicinity in Ludhiana. For the purpose of water collection site has been divided into two parts.

1) Budha Nullah
2) Vicinity area of Budha Nullah (within 500m perpendicular distance)
3) Area away from Budha Nullah (> 500m perpendicular distance from) Budha Nullah

TABLE: Site details of water quality sampling stations of 6 km stretch from starting point of Budha Nullah

Sample no.	Source	Location	Distance from Budha nullah (m) approx.
1	Tubewell	Opp treatment plant, Jamalpur	10-20
2	Budha Nullah	Tajpur road (Near Gurjit Public School)	-
3	Handpump	Tajpur Bhonian link road	50-60
4	Budha Nullah	Mohar Singh Nagar	-
5	Tubewell	Residential area, 3 no gali, Mohar Singh Nagar	30-40
6	Budha Nullah	48 MLD STP, Jamalpur	-
7	Tubewell	STP, Jamalpur	10-20
8	Budha Nullah	Near Chand Cinema, Tajpur road.	-
9	Budha Nullah	Near Old Sabji Mandi, Tajpur Road	-
10	Tubewell	Near Old Sabji Mandi, Tajpur Road	15-25

11	Budha Nullah	gaushala road	-
12	Budha Nullah	near mehak telecom, gaushala road	-
13	Tubewell	near mehak telecom, gaushala road	40-50
14	Handpump	Near cremation ground, gaushala road	400-450
15	Tubewell	Near rahon road	400-450
16	Tubewell	jain nagar	200-250
17	Handpump	jain nagar	250-300
18	Tubewell	near chand cinema, clock tower road	900-1000
19	Tubewell	Residential Area, Upkaar Nagar.	20-30
20	Budha Nullah	Near Sanatan Vidya Mandir.	-
21	Tubewell	Near Sanatan Vidya Mandir.	40-50
22	Tubewell	Residential Area,Joshi Nagar.	30-40
23	Tubewell	Residential Area,Joshi Nagar.	20-30
24	Hand pump	Near Haibowal Khurd Road.	30-40
25	Budha Nullah	Near joshi Nagar	-
26	Tubewell	Near Lord Mahavir Hospital,Haibowal.	40-50
27	Tubewell	Haibowal.	20-30
28	Budha Nullah	Near Haibowal.	-
29	Tubewell	Haibowal .	20-30
30	Hand pump	Village Churpur.	40-50
31	Tubewell	Kulbir Singh Dairy, Village Churpur.	50-60
32	Budha Nullah	Near 152 MLD STP, Balloke.	-
33	Tubewell	152 MLD STP, Balloke.	450-500
34	Tubewell	Green Avenue,Churpur.	600-700
35	Budha Nullah	Near Village, Churpur.	-

Site Locations on Map

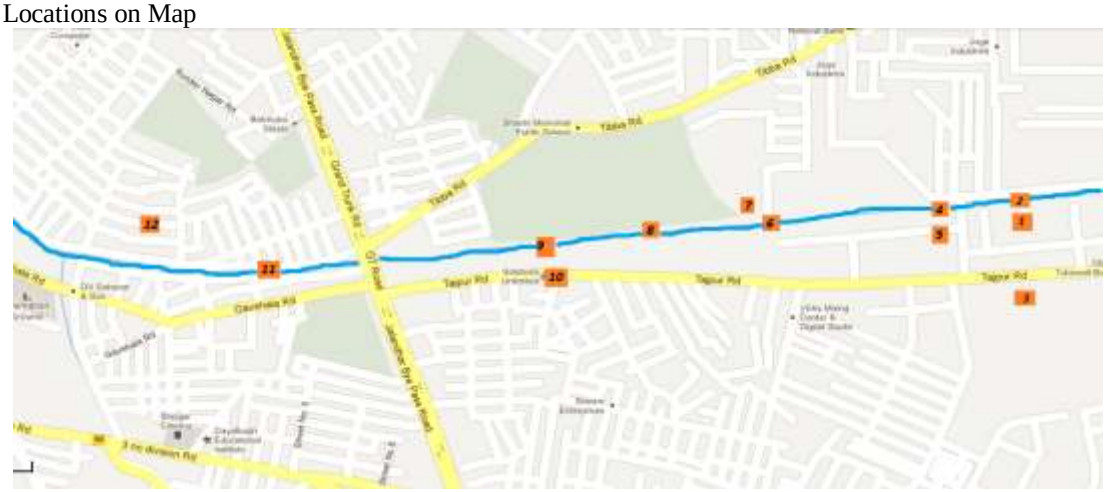
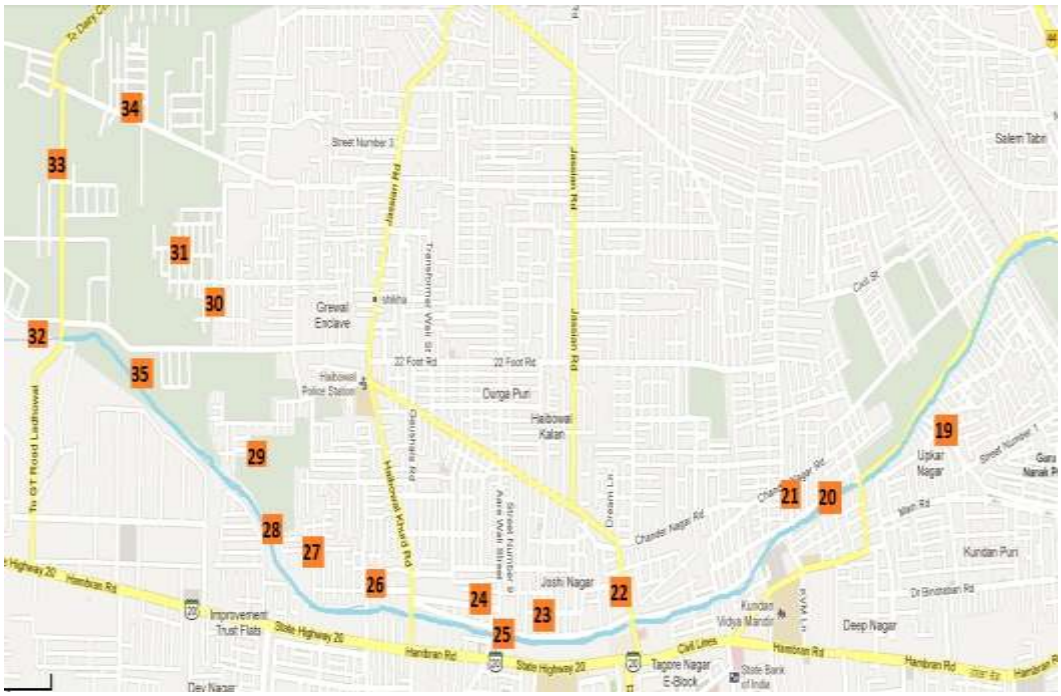


Figure 3.1



Pollution Parameters Analyzed

Various impurities present in water are expressed through pollution parameters. These are broadly classified into three categories namely:

1) Physico-chemical parameters:

The parameters analyzed in this study were pH, color, Total hardness as $CaCO_3$, chlorides, Total Dissolved Solids, Alkalinity and Chemical Oxygen Demand (COD).

2) Biological parameters:

The biological parameters analyzed in present study included Biochemical Oxygen Demand (BOD) and Most Probable Number (MPN).

3) Heavy metal testing:

The heavy metals analyzed were Arsenic, Boron, Calcium, Cadmium, Chromium, Copper, Iron, Lead, Potassium, Magnesium, Manganese, Phosphorous, Sulphur Sodium, Nickel and Zinc.

Analytical methods and equipments used in the study

S. No	Parameter	Method	Instrument/Equip-ment
1	pH	Electrometric	pH meter
2	color	Electrometric (Pt-Co scale)	DR 2800 HACH
3	Total hardness as $CaCO_3$	EDTA titrimetry method	Titrimetry
4	Chlorides	Argentometric method	Titrimetry
5	Total Dissolved Solids	Gravimetry method	Oven
6	Alkalinity	Potentiometric titration	Titrimetry
7	Chemical Oxygen Demand	Digestion followed by titration	COD digestor
8	Biochemical Oxygen Demand	5 days incubation followed by titration	BOD incubator
9	Most Probable Number	Coliform MPN	Bacteriological Incubator, autoclave, laminar flow
10	Arsenic, Boron, Calcium, Cadmium, Chromium, Copper, Iron, Potassium, Magnesium, Manganese, Sodium, Nickel, Zinc	Inductively Coupled Plasma method	ICAP-AES
Where ICAP-AES = Inductively Coupled Argon Plasma – Atomic Emission Spectrometry			

Table showing results of water samples

S.No.	PARAMETERS	IS10500:1991 DESIRABLE LIMIT	COMPARISION RESULT
1	pH	6.5 – 8.5	All samples are within range
2	Chlorides	250 mg/L	Sample 2, 4, 6 ,8, 9, 11, 12, 17, 18, 20, 25, 28,32 and 35 have chloride content greater than desirable limit
3	Alkalinity	200 mg/L	All the samples have value lower than desirable limit
4	Biochemical Oxygen Demand (BOD)	0 mg/L	BOD is present in all the samples
5	Chemical Oxygen Demand (COD	0 mg/L	COD is present in all the samples
6	Total dissolved solids	500 mg/L	Sample 3, 4, 6, 7, 8, 11, 12, 17, 20,25,28,32 and 35 have TDS greater than desirable limit
7	MPN	10 per 100ml	All the samples haveMPN values greater than desirable limit
8	Arsenic	0.05 mg/L	All samples have value lower than desirable limit
9	Boron	1 mg/L	All samples have value lower than desirable limit
10	Calcium	75 mg/L	All samples have value lower than desirable limit
11	Cadmium	0.01 mg/L	All samples have value lower than desirable limit
12	Cobalt		
13	Chromium	0.05 mg/L	Sample 25, 26, 30, 33 and 34 have value greater than desirable limit
14	Copper	0.05 mg/L	Sample 4, 21, 24, 29 and 30 have value greater than desirable limit
15	Iron	0.30 mg/L	Sample 4, 7, 8 ,9, 11, 12, 17, 20, 25, 28, 32 and 35 have value greater than desirable limit
16	Potassium		
17	Magnesium	30 mg/L	All samples have value lower than desirable limit
18	Manganese	0.1mg/L	Sample 3 and 26 have value greater than desirable limit
19	Sodium		
20	Nickel	0.02 mg/L	Sample 11, 17, 23, 25, 32 and 35 have value greater than desirable limit
21	Phosphorous		
22	Lead	0.05 mg/L	All samples have value lower than desirable limit
23	Sulphur		
24	Zinc	5mg/L	All samples have value lower than desirable limit

SOIL QUALITY ANALYSIS: Materials and methodology

Location of sampling source:

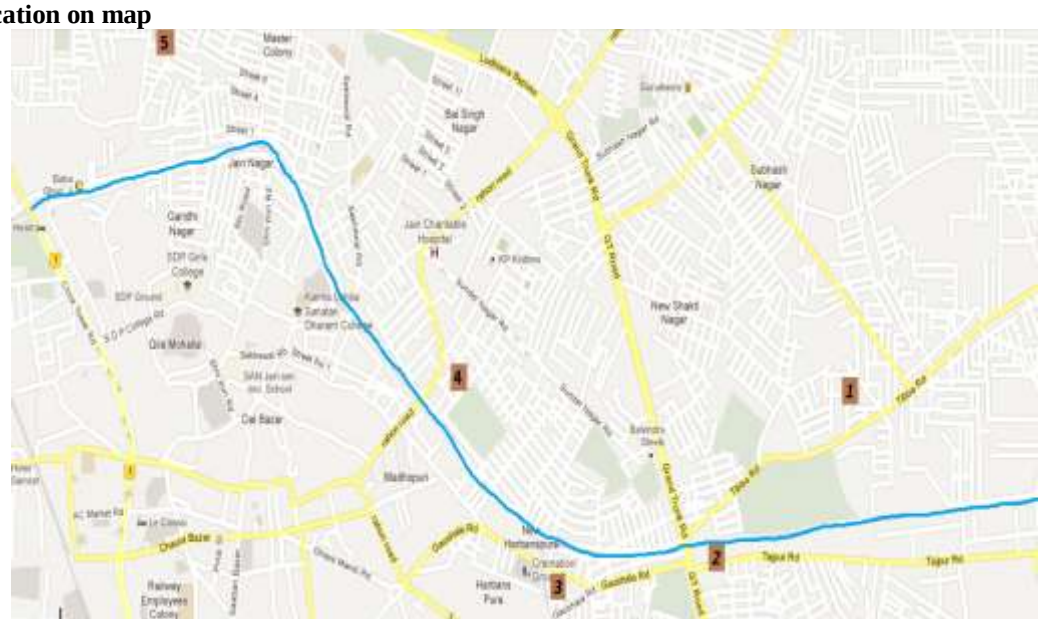
Soil samples were collected from vicinity of Budha Nullah in Ludhiana. For the purpose of water collection site has been divided into two parts.

1) Vicinity area of Budha Nullah (within 500m perpendicular distance)
2) Area away from Budha Nullah (> 500m perpendicular distance from) Budha Nullah

TABLE: Site details of soil sampling stations

Sample no.	Location	Distance from Budha Nullah (m) approx.
1	Opp treatment plant, Jamalpur	500-550
2	Near Old SabjiMandi	5-10
3	Gaushala Road	40-50
4	Rahon Road	100-150
5	Jain Nagar	600-650
6	Upkaar nagar	30-40
7	Joshi nagar	40-50
8	Haibowal	40-50
9	Green Avenue, Churpur	600-700
10	Near 152 MLD STP, Balloke	50-60

Site location on map



Figure

Table: Results of soil samples

S.No.	PARAMETERS	RANGE OF METALS PRESENT IN ALL SAMPLES (mg/L)
1	Arsenic	Lies between 0.007-0.014
2	Boron	Lies between 0.088-0.179
3	Calcium	Lies between 298.2-508.4
4	Cadmium	Lies between 0.004-0.144
5	Chromium	Lies between 0.005-0.021
6	Copper	Lies between 0.358-11.484
7	Iron	Lies between 2.447-6.584
8	Potassium	Lies between 10.46-28.32
9	Magnesium	Lies between 47.2-108.9
10	Manganese	Lies between 2.72-5.24
11	Nickel	Lies between 0.014-8.746
12	Phosphorous	Lies between 0.043-1.541
13	Lead	Lies between 0.354-3.864
14	Sulphur	Lies between 8.43-89.14
15	Zinc	Lies between 0.583-36.02
16	Sodium	Lies between 49.4-156.4

SAR VALUES OF SOIL SAMPLES

SOIL SAMPLE	SAR VALUE
1.	6.98
2.	3.78
3.	6.03
4.	5.26
5.	5.12
6	7.12
7.	3.35
8.	9.57
9.	9.22
10.	4.54

III. Conclusions And Recommendations

Conclusion:

1) The quality of the surface water at different stretches of Budha Nullah has been impaired as the stream progresses through the city. Untreated waste from the industries and human settlements are found to be the major cause for deterioration in the water quality in Ludhiana. The surface water analysis of Budha Nullah reveals high values of Total Dissolved solids up to 1642 mg/L, chlorides up to 400 mg/L, Chemical Oxygen Demand values up to 448mg/L, Biochemical Oxygen Demand varying between 52-195 mg/L, Most Potable Number varying from 240+ upto 2400+ per 100ml, heavy metal like Cr in the Budha Nullah has value 0.084 mg/L, Fe 0.913 mg/L, Mn 0.095 mg/L and Ni 0.222 mg/L. As per the water quality criteria given by Central Pollution Control Board (CPCB), the water quality of Budha Nullah comes under E class of water which is not suitable for drinking, outdoor bathing, propagation of wildlife and fisheries, irrigation and industrial cooling.
2) Most of the Heavy metals were within permissible limit except iron which was found to be more than permissible limit in samples of the Budha Nullah as well as groundwater
3) The quality of ground water at many places was found to be unfit for drinking mainly due to high amount of total dissolved solids and most potable number being much higher than the prescribed limit under CPCB.
4) Heavy metals were found in samples of groundwater in the vicinity of Budha Nullah and their concentration decreases as we move away from the Budha Nullah. So it can be concluded that presence of heavy metals in groundwater is due to seepage of surface water of Budha Nullah into the aquifer.
5) BOD values of groundwater was also high ranging from 2 to 12 due to which it falls under category E i.e. it is unfit for human consumption but can be used for irrigational purposes.
6) pH parameter analyzed in ground water samples as well as Budha Nullah were within the range of IS:10500 Drinking Water Standards between 6.5-8.5.
7) Amount of calcium in soil ranges from 298.2 to 508.4 mg/kg, sulphur from 8.43 to 89.14 mg/kg, nickel ranges from 0.076 to as high as 8.746 mg/kg.
8) SAR of soil ranges from 3.35 to 9.57 mg/kg, which is optimum value for soil, as soils with SAR value less than 10 are considered good for leaching and water percolation.

Overall Comment On Water Quality Assessment

Surface water of Ludhiana is highly contaminated by the effluents released by the industries and sewage which is added by the human settlements. This is the main reason for the heavy metals contamination and presence of microbes in the surface water.

Surface water of Budha Nullah is highly colored, the main reason for this is the colored effluents that are released particularly by the textile industries.

Dumping of the garbage into the water also obstructs the flow of this Nullah due to which at many places the water is Stagnant which hinders the self –purification mechanism of water and is one of the major factors for the occurrence of diseases like malaria, jaundice, cholera, diarrhea and gastroenteritis. Callousness approach of the people in the city has rendered the surface water of Budha Nullah to come under E class of water, which cannot be used for drinking, outdoor bathing, propagation of wildlife and fisheries, irrigation and industrial cooling.

Heavy metal analysis of all the ground water samples is within the desirable limit.

MPN values are high in the ground water, which indicates microbial contamination of water.

Recommendations For Water Quality Assessment

Regular monitoring of the water should be done.

The results of the analysis of water should be published for the purpose of record and benefit of public.
Strict laws should be imposed on the industries which release their effluents directly into the water.
Regular monitoring of small scale industries which are also a major contributor for polluting the surface water and ultimately contaminates the ground water.
Educating the people about the various problems specially the labour class that works in industries will also help to clean the environment as the best way to manage the environment, is to manage ourselves.

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