INNOVATIVE ENERGY TECHNOLOGY SYSTEMS AND ENVIRONMENTAL CONCERNS: A SUSTAINABLE APPROACH
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Industrial Effluents and Their Impact on Ground Water Quality and Human Health in Guwahati City, India: A Geographical Analysis

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Abstract

Industrial effluents coming from different industrial and commercial establishments are posing a serious threat to environment, particularly in urban and semi urban areas. It becomes the source of pollution for surface and subsurface soil, water and air. Huge industrial establishment and their indiscriminate discharges pose a great threat to our environment. Industrial wastewater deteriorates not only the quality of soil, crop and environment but are also directly harmful to the human, animal and aquatic lives. The present study evaluates the impact of industrial effluent on ground water quality and human health in Guwahati city in Assam. The study is aimed to find out major industrial area in Guwahati city and the impact of industries on local people. The main thrust of the study is on the health status of the people in industrial area and finally finds out measures to mitigate the problems. To fulfil the aim field survey has been done and data are collected from both primary and secondary sources. Water samples has been collected in PET bottles of one litre size to know the quality of ground water. Results of the analysis are presented in tables, cartograms and maps wherever applicable. The conclusions of the study have been drawn on the basis of the findings derived from the analysis of both primary and secondary data and also from personal observations in the field.

1. Introduction

Water in natural conditions may contain impurities because it dissolves the substances while moving downward as part of hydrological cycle. Groundwater pollution can be caused by three major sources:(i) Weathering of soil and rock minerals,(ii) Decomposition of organic materials and (iii) Industrial effluents ,sewerage and municipal waste water [12]. Although groundwater pollution can be happened from the said sources however, that occurrences on trace elements in ground water were directly related to soil characteristics that determine that the water movement [2]. In general, shallow, permeable water table aquifers are the most susceptible to contamination.

The dilemma of ground water pollution is that it is not easily detectable. Almost every instance of ground water pollution has been discovered only after a drinking water supply was affected. Ground water pollution is occurring either by directly or indirectly depending on the local condition. Direct or point source occurs when source is potential pollutants i.e. indiscriminate disposal of municipal solid waste, medical waste and industrial waste or if septic tanks are close to ground water. The leakage of drinking water pipe or percolating the surface water through these sources can directly pollute the ground water [4].

Industrial pollution has been and continues to be a major factor causing the degradation of the environment around us, affecting the water we use, the air we breathe and the soil we live on. But of these, the pollution of water is arguably the most serious threat to current human welfare. Water is polluted not only by industries but also by households. Both industries and household wastewater contain chemicals and biological matter that impose high demands on the oxygen present in water. Polluted water thus contains low levels of dissolved oxygen as a result of the heavy biological oxygen demand (BOD) and chemical oxygen demand (COD) placed by industrial and household waste materials discharged into water bodies and water systems, both above and below the earth's surface. In addition to low levels of dissolved oxygen in water, industrial wastes (effluents) also contain chemicals and metals that are directly harmful to human health and the ecosystem.

On a global scale, environmental pollution by food or related industries via effluent discharge has become a threat to plants and animals and may ultimately threaten the quality of human life. In 1956, cases of minamata disease were reported in Japan [9]. The disease affects the brain, causing insanity and leading to death, as a result of pollution of water by industrial effluents containing methyl-mercury. Also, the Itai-Itai disease caused by cadmium poisoning originated in a factory in Japan. This disease damages the joints, softens the bones and causes the body to shrink and the affected person dies painful death [10].

The importance of water in the control of diseases had long been recognized [5,2, 13].Water is a factor of production in virtually all enterprise, including agriculture, industry and the services sector. The importance of safe drinking water is underlined by the assertion that: "safe drinking water is the birthright of all humankind–as much a birthright as clean air" [12].It also reported that the majority of the world's population, especially in most parts of Africa and Asia, does not have access to safe drinking water and that as much as 6 million children dies daily as result of waterborne diseases linked to scarcity of safe drinking water or sanitation [12]. Diseases related to contamination of drinking-water constitute a major burden on human health and that interventions to improve the quality of drinking-water provide significant benefits to health [15].

For most communities the most secure source of safe drinking water is pipe-borne water from municipal water treatment plants. Often, most of water treatment facilities do not deliver or fail to meet the water requirements of the served community; due to corruption, lack of maintenance or increased population. The scarcity of piped water has made communities to find alternative sources of water: ground water sources being a ready source. Wells are a common ground water source readily explored to meet community water requirement or make up the short fall.

Wells are categorized based on the nature of construction. Open dug wells are generally considered the worst type of groundwater sources in terms of faecal contamination and bacteriological analysis. Dug wells with windlass or hand pumped or mechanically pumped well are generally regarded to be less prone to contamination [15]. Open or poorly covered well heads pose the commonest risk to well-water quality; the possibility of the water being contaminated is further increased by the use of inappropriate water-lifting devices by consumers[12]. The commonest physical defects leading to faecal contamination of dug wells are associated with damage to, or lack of, a concrete plinth, and with breaks in the parapet wall and in the drainage channel [14]. The most serious source of pollution of well water is contamination by human waste from latrines and septic tanks resulting in increased levels of microorganisms, including pathogens. Other likely sources of contamination include runoffs,

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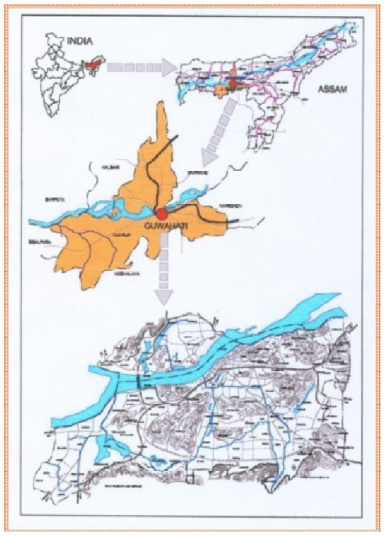
agrochemicals such as pesticides and nitrates used on farm lands and industrial effluents. Contamination of well water due to under seepage has reported in the Niger delta area of Nigeria [6]. Seepage from effluent bearing surface water would readily contaminate wells located close to the surface water.

2. Study Area

Guwahti city, the capital of Assam is located on the south bank of river Brahmaputra towards the south eastern side of Kamrup district. The absolute location of the city extends approximately from 91^0 $38^/$ E to 91^0 $51^/$ E longitude and from 26^0 $5^/$ N to 26^0 $12^/$ N latitude. In the northern side, the city is bounded by mighty river Brahmaputra and in the southern side; the city is surrounded by hillocks which is the extension of Khasi hills. In the west and the south west there is the Rani Reserve Forest, Deepar Beel wet land and the alluvial tracts of the Brahmaputra plain. The city is situated on an undulating plain with varying altitudes of 49.5 m to 55.5 m above mean sea level. The topography of the city is made up of both high land and low land.[3]



Map 1

3. Objectives of the Study

The main objectives in this study are to identify the major industrial area in Guwahati and the impact of industries on local people. The study also highlight the major health hazard zone of the area and finally find out measures to mitigate the problems.

4. Materials and Method

The study was based on both primary and secondary information. The primary data were collected randomly from the field by adopting questionnaire and interview method. A questionnaire was designed for collecting the data. The secondary data were collected from Census of India, Assam Remote Sensing Application Centre, Guwahati Municipal Corporation Office and many other government office, agencies, institutions. Water samples were collected in PET bottles of one litre size. A total of 30 water samples were collected from the five different zones of the well and tested in the laboratory.

The findings are shown as a tables, cartograms and maps wherever applicable.

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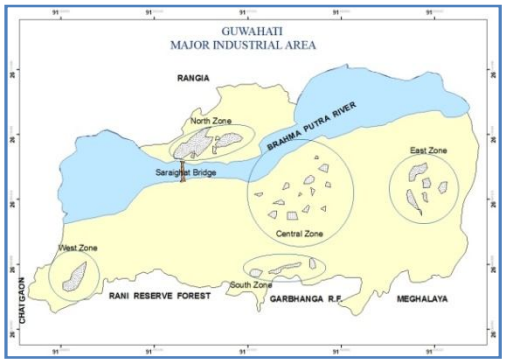
5. Results and Discussion

Guwahati the capital city of Assam and gateway of north east India is cover the total area 326 sq km. The mighty river Brahmaputra is flowing northernmost side from east to west. So, for the better analysis the city is divided into five major zones named north zone, south zone, east zone, west zone and central zone (Map 2).



Map 2

The north zone is situated in the northern bank of river Brahmaputra. The Saraighat bridge is only bridge to link the area. Due to availability of land many industries are developed in this area. It is mainly identified as Amingaon Industrial Estate. This industrial estate consists of around 36 small and large industries like furniture industries, cosmetic industries and textile manufacturing company.The south zone is identified as Pamohi, Bhetapara area. This area includes the Jyoti Drop Packaged Drinking Water and SRK industries. East zone is Basistha area. In this area cardboard factory is only important factory. The west zone is Azara area. In this area soft drinks and mineral water factories and RCC hume pipes and concrete manufacture factories are available. The central zone is the core area of the city. This area encompasses the Kalapahar industrial area, Bamunimaidan industrial estate, Noonmati refinery area and Assam Carbon factory area. Due to the requirement of various goods on a daily basis minor and light industries were and are still being set up within and vicinity of the city.

The impact of industries to the society is immense. it always helps to all round develop of the society but very often rapid growth of industries are silently effect the society by polluting air, water and soil. Now ground water pollution in Guwahati is increased day by day and it creates problem to the people (Fig. 1).

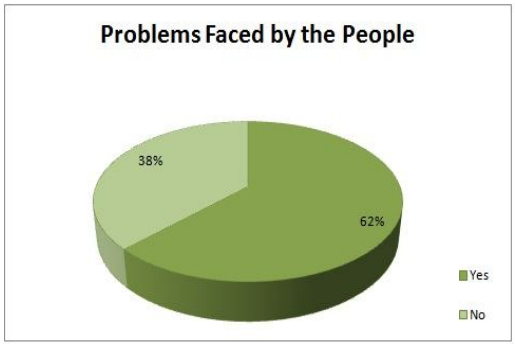


Fig. 1

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In survey area 62 percent people explain that the rapid growth of different industries are polluted their ground water and finally it pose as a problem to them. The increasing amount of water related disease are alert the people regarding this problem. The present situation of the water bodies of Guwahati is effected by both sewage disposal and industrial effluents. The sources of drinking water of the people in the city is as Fig. number 2.

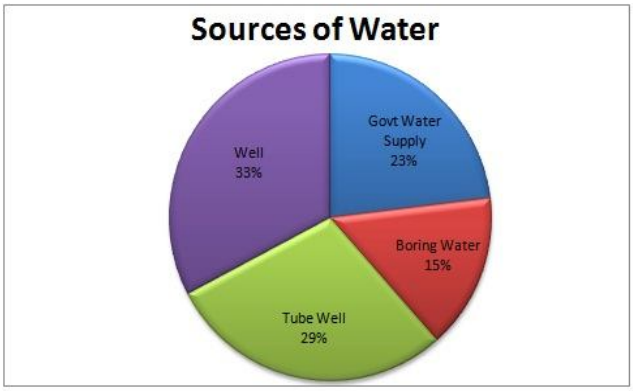

Fig. 2

The 33 percent people in study area are used well water, 29 percent people are used tube well water, 23 percent people are used Government supply water and remain 15 percent people used boring water. The zone wise sources of water is shown in table 1and figure. No government water supply has seen in south zone and no boring has seen in north zone.

Table 1: Sources of water in zone wise (in percent)

Sources	North Zone	East Zone	Central Zone	South Zone
Govt. Water Supply	30	20	50	0
Boring Water	0	30	30	10
Tube Well	30	10	10	50
Well	40	40	10	40

Source: Field Survey,2014

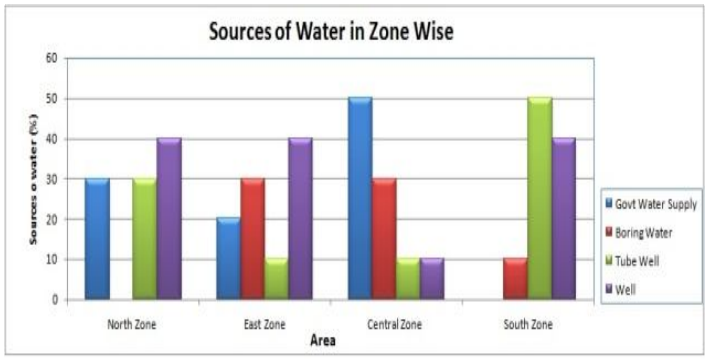

Fig. 3

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The Fig. 4 shows the problem faced by the people in zone wise. In central zone 80 percent people said that they faced different problems.65 percent people in south zone and 50 percent people in north and east zone explained that they also faced some problems respectively.

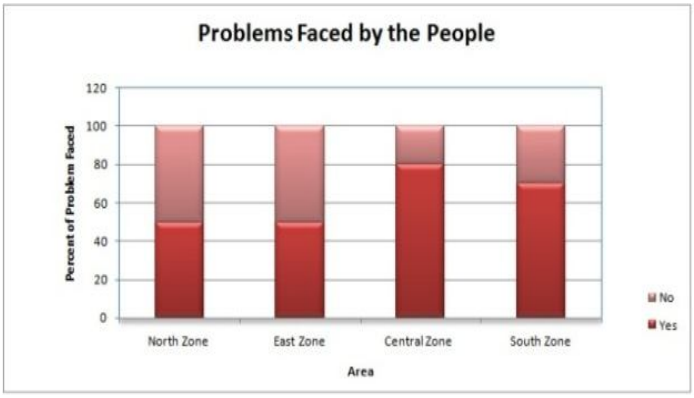

Fig. 4

The people in different zone are economically not in same. There income level is not same. Depending upon the financial condition people adopt different types of method to purify their water. The Fig. 5 shows the method they adopt.

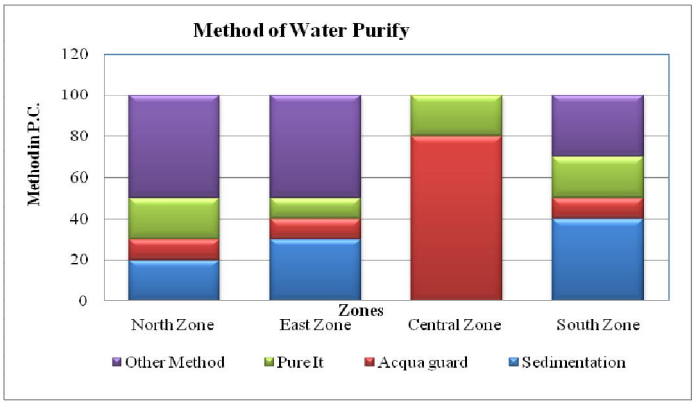

Fig. 5

The physicochemical characteristics of the water near the industrial area are shown in table 2. Water from the wells was observed to be coloured and turbid with the value ranges of 211-2519 Pt-Co and 1.5–250 mg/l respectively. Thin films of oil present on the water surface appear to make the value of the colour to be very high.

Table 2: Physicochemical characteristics of the water near the industrial area.

Parameters measured	North Zone	South Zone	East Zone	West Zone	Central Zone
pH	6.9	5.97	7.3	10.04	6.9
Colour (Pt-Co)	211	2519	1000	720	240
Turbidity (N.T.U)	1.5	250	200	165	4.6

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Temperature (oC)	27	28	25	26	28
Total Hardness(mg/l)	232	96	196	44	260
Calcium Carbonate(mg/l)	232	96	196	44	260
Magnesium Hardness(mg/l)	46	57	42	52	48
Calcium ion (mg/l)	410	383	110	104	135
Chloride(mg/l)	20	100	60	20	60

Source: Field Survey,2014

The high turbidity value is as a result of increase in the type and concentration of the suspended matter released by the industry. The content of total solids, suspended and dissolved solids are also high. This is attributable to the industrial waste discharged into the surface water and suggests some of the content of the effluent have found their way into the ground water. Well water containing high total solids, total suspended solids and total dissolved solids are not fit for drinking, laundry work and livestock purpose. The high conductivity values suggest that the dissolved solids are mostly mineral salts. The high chloride is also suggestive of the use of large quantity of chlorine or its associated compounds in activities within the industrial estate. The high bacterial count is suggestive of presence of organic matter.

Bacteriological speaking water from the wells fall short of the WHO (1997) recommended guideline standard for drinking water. It requires that water intended for drinking should not contain any pathogen or microorganisms indicative of faecal contamination. All the water samples examined contained feacal coliform (*E. coli*) and high population of heterotrophic bacteria, which is consisted with WHO (2004) report that open dug wells are contaminated, with levels of at least 100 faecal coliforms per 100 ml. This is not necessarily a result of the citing of the well along the river course but a reflection of the human activities taking place around the catchment of the wells. The unringed nature of the wells makes contamination by seepage from the soil more likely. The WHO (2004) recommends that wells are ringed and provided with an apron around the head to minimize contamination. The bacteriological quality of the wells requires that they be subjected to treatment if they are to be used for drinking and domestic purpose.

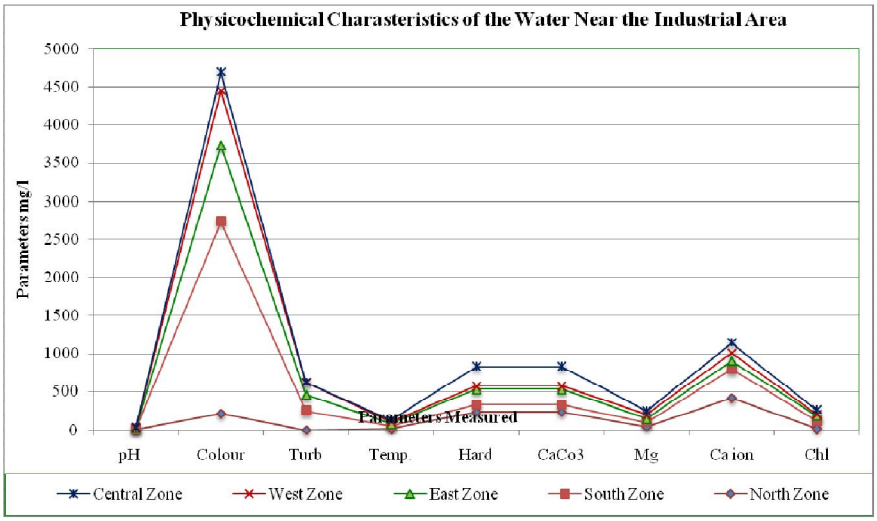

Fig. 5

The physicochemical characteristics near the industrial area shows that the central zone is most vulnerable in terms of high colour content, turbidity,total hardness, calcium carbonate, calcium ion and chloride. This area is core part of the city. Due to rapid growth of population and industrialisation the area makes more vulnerable then other industrial area.The water borne disease is found all over the city. The disease like jaundice, diarrhoea, is common among the people in the city. The water borne disease-cholera in the city, in 2007 had taken the lives of three people in Padumbari area of Uzan Bazar.

6. Summary and conclusion

The study shows that the environmental impacts of industrial effluent is different for different sites, which is mainly due to the fact that different industries have different pollution potential; and different locations have different assimilative capacities to absorb the pollutants.

The present situation of the water bodies of Guwahati is affected by both sewage disposal and industries. However the location of major industries lies in the outskirts of the city but minor industries whose production houses are built inside the city premises releases the harmful chemical waste into the sewers as sewage. Minor and light industries doesn't release toxic effluents like the major industries but the solid waste produced in these industries which includes plastics and other organic waste is directly dumped into the sewers. This has a harmful impact as the city lacks a proper sewage treatment plant and the sewage is directly dumped into the river Brahmaputra without necessary treatment.

The major industries lie in the outskirts of the city of Guwahati. Since the water requirement of these industries are much larger so it is conveniently built near a water body such as the river Brahmaputra or other water bodies such as the Deepor beel. The present releases of effluents from industries have not been controlled even after important laws were made by the Government of India regarding this situation. The industries need to have a proper treatment system through which the waste water has to go through before being released into a water body. However very few industries have a proper treatment plant and dumps effluents and waste directly into the rivers or the nearby water body. This is a rising concern relating to the pollution of river Brahmaputra.

The city suffers from lack of proper sewage disposal system and sewage treatment system. This is one of the major causes of pollution of water bodies and a rising matter to be looked into.

The unplanned industrial growth is contributed to water pollution in the city. The strict pollution control laws and legislation, and their effective implementation do have an important role in controlling any kind of pollution. The development of affordable pollution control equipment and incentives from Government for installing such equipment can encourage industries to take up pollution control seriously. Pollution presentation is to be reduce by eliminating waste at the source by modifying production processes, promoting the use of non toxic substances, implementing conservation techniques, and reusing materials rather than putting them into the waste stream.

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