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Research Article

Studies on Ground Water Pollution due to Iron Content in Bhubaneswar, Odisha, India

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Abstract

A study has been carried out in Bhubaneswar city, Odisha, India, to ascertain the causes for the origin and distribution of iron content in the ground waters. Ground water samples were collected quarterly for two consecutive years and analyzed for iron content. The iron content ranges from 0.32 to 7.7 mg/l. A comparison of ground water data with rock and soil chemistry suggests that the concentration of iron in the ground water is derived from the rock and soils due to geogenic processes. This concentration is taken as a natural occurrence of iron in the groundwater of the study area for assessing the causes for its next higher content. Relatively higher concentration of iron is observed in some samples where the wells are located nearby municipality waste waters, indicating the impact of anthropogenic activities on the ground water system. These activities mask the concentration of iron caused by geogenic origin. Hence, both the geogenic and anthropogenic activities degrade the ground water quality. Drinking water standards indicate that the iron content in all the ground water samples exceeds the permissible limit (0.3 mg/l) recommended for drinking purpose causing the health disorders. Necessity of close monitoring of ground water quality for assessing the impact of geogenic and anthropogenic sources with reference to land use and land cover activities is emphasized on the present study area to protect the ground water resources from the pollution.

Keywords: *Ground Water Pollution, Iron Content etc.*

Introduction

Urban growth and rapid increase in population have induced tremendous pressure on natural resources. A common factor to most urbanization is that it results in impermeabilisation of a significant proportion of land surface and contamination of ground water. On the other hand concern about the degradation of water quality is now widespread among the public as the water is of utmost physiological importance in the human body. About 80% of the diseases of the world population and more than one-third of the deaths in the developing countries are due to contamination of water (WHO 1984; Earth summit 1992). Trace elements are essential for human health. However excess concentration of these elements cause health disorder. Man can control some undesirable chemical constituents in water before it enters into ground water. But once the water enters ground man's control over the chemical quality of percolation water is very limited (Jhonson 1979). Hence the understanding of the processes that controls the water quality is needed before one can speak about water quality and improvement (Hem 1991; Rao et al 2006).

Groundwater composition in a region depends on the natural (such as wet and dry deposition of atmospheric salts, evaporation, soil/rock-water interaction) and anthropogenic processes, which can alter or modify the natural system of hydrological cycle (SubaRao 2002 2006). Zuane (1990) has stated that the type and extent of chemical contamination of the ground water is largely dependent on the geochemistry of the soil through which the water flow prior to reaching the aquifers. Romic and Romic (2003) have pointed out that iron in the ground waters is mainly derived from geogenic (pedogenic) process in the urban area. Rajmohan and Elango (2005) have stated that the distribution of iron content in the ground water is due to lithogenic and non lithogenic sources in Palar and Cheyyar river basin, Tamilnadu, India. Ramesh et al (1995) have explained the unequal distribution of major and trace elements in the groundwater because of anthropogenic activities such as sewage waste, industrial effluents etc.and improper management of natural resources in Madras City, Tamilnadu, India. Raju (2006) describes the iron contamination in the ground waters caused by dissolution of rocks and ferruginous minerals, iron related smelting processes and seepage of domestic sewage effluents in Tirumala-Tirupathi environs, Andhra Pradesh,India. Eswari and Ramani (2000) have estimated

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the seasonal variation of iron in the waters of Chennai, Tamilnadu, India.

Most of the population in Bhubaneswar, a rapidly growing urban area in east India depends upon the ground water resources for drinking purposes due to scarcity of surface water supply. Hence the present paper deals with the causes for the origin and distribution of iron content in the ground waters as the iron plays a significant role on human health among the trace elements. A deficiency of iron causes anemic, while an excess of iron develops undesirable taste and gastrointestinal irritation. Moreover, it stains the cloths, teeth, gum and utensils, promotes the growth of bacteria and reduces the water flow. Abnormal content of iron leads to cancer(Micozzi).

The capital city of Odisha- Bhubaneswar is located between $20^0$12'N and $20^0$25'N latitude and $85^0$44'E to $85^0$55'E longitude on the western fringe of coastal plain across the main axis of Eastern Ghats in Khurda district of Odisha. The city has witnessed a dynamic change in growth of population. The city designed for a population of 40,000 in 1954 with an area of 1684Ha holds as many 837737 (2011) which is expected to increase to 16,87,087 by 2031. The present city sprawls over 233 sq km comprising of total 2312 revenue villages. The shape of the city is almost dumble shape. Its boundary in the south, southeast, and east are somehow irregular. The city is divided into 30 wards under the Bhubaneswar Municipality Corporation control. There are 204 more villages along the rural periphery, which are also coming under the direct influence of the city. As a result there is tremendous pressure on resources like ground water. Although the city lies on the western side of the Mahanadi Delta on the bank of river Kuakhai, a distributary of mahanadi along with river Daya, branching off from Kathajodi that flows along the southern part of the city, 35% of water supply depends heavily on dug well and bore wells.

Bhubaneswar enjoys a salubrious and moderate equable humid tropical climate with average maximum temperature around 38^oC and average minimum temperate of 16^oC. Bhubaneswar receives about 120 cm of rain fall during southwestern monsoon (June to September) which contributes to about 75% of the annual rain fall . Southwest monsoon generally arrives over Bhubaneswar by second week of June and prevails up to second week of October. During this period more than 45% are rainy days. The relative humidity varies from 48 to 85%.

Tropography

Bhubaneswar lies on the western fringe of the mid-coastal plain of Odisha with an average elevation of 45m above the main sea level. It lies on the low lateritic plateaus and the erosion has made its topography a valley-and- ridge one. The area can be divided into two broad physiographic divisions, namely (a) the Western Upland and (b) the Eastern Lowland. The general slop of the land is from the west to the east, south and southwest. Most of the areas lying in the east and southeast along the three rivers have an average slope below 1^o. The areas lying in the middle and northwest have an average slop ranging from 1.5^o to 2.0^o.

Geology

Geologically the Bhubaneswar region belongs to the Gondwana land mass, one of the oldest and most stable landmass in the world. So the rocks ranges from the Archean to the recent period. But the major part of the area is covered with the quaternary alluvium and lateritic soil.

Hydrology

Upper Gondwana rocks are grouped as the semi consolidated formations. The older and the younger Alluviums which occur to the east of the city are the unconsolidated formations. The depth of water table ranges from 5-12m in the Laterites and the weathered sandstones to 40-150m in the fractured and friable sandstones forming the deeper aquifers that are under semi-confined to confined conditions. The rock types in and around the western parts of the city store water recharged by rainfall. The recharge may dwindle in future as urbanization crawls further.

The deeper water levels are mostly observed in the western part of Bhbaneswar and shallow water levels from eastern part of the city along the river in the flood plain. The depth is maximum up to 6m bgl in December that falls to 8m bgl in May. The trend of level of ground water in last decade shows that fall and rise in groundwater level are restricted within 0.5m that indicate there is no significant change in groundwater regime quantitatively during these period. (Fig-02).However there are enough reasons for a greater decline in next two decades.

Methodology

To have a through idea regarding the iron content in ground water of Bhubaneswar, nine different locations were chosen. The locations were chosen keeping in mind that all the areas of Bhubaneswar can be covered properly. The detailed locations of sampling points are described in table-01. From each location a particular tube well was chosen and grab sampling was done quarterly from that particular tube well. The samples were collected in glass bottles as per requirement.. After sample collection and under preservation, the samples are analyzed in laboratory following water and waste water analysis by **APHA 2000(19th Edition). T**he analysis for the iron content was done with the help of Atomic Absorption/Flame Emission Spectrophotometer (ShimadzuAA/640 of Japan make), using air and acetylene flame (Brown et al.1974). In this procedure pure analytical reagent iron metal was dissolved in the concentration nitric acid. From this by multiply dilution six known standards were prepared for drawing the calibration curve from which the unknown amounts were determined. All the samples were run thrice against the standard and average values were recorded. Minimum detected limit of iron is 0.01%. The concentration of iron is expressed in mg/l.

Table-01 Locations of ground water sampling stations of Bhubaneswar

Stations	Locations	Code No
1	Khandagiri area	L-01
2	Unit-1X area	L-02
3	Capital Hospital area	L-03
4	Chandrasekharpur area	L-04
5	Unit-1 area	L-05
6	Samantarapur area	L-06
7	Rasulgarh area	L-07
8	Laxmisagar area	L-08
9	Unit-111 area	L-09

Result and Discussion

Table-01 shows the results of iron content determined from the groundwater of study area for two consecutive years. The iron concentration in samples varies from 0.32 to 7.7 mg/l. Except Location-01, all the stations recorded much higher values than the prescribed limit by WHO i.e 0.3 mg/l. No seasonal variation was observed in samples. Iron in ground water supplies is a common problem, its concentration level ranges from 0.0 to 50.0 mg/l, while WHO recommended level is <0.3 mg/l. The iron occurs naturally in the aquifers but levels in ground water can be increased by dissolution of ferrous bore holes and hand pumps components. Iron dissolved in ground water is in the reduced iron(II) form. This form is soluble and normally does not cause any problem by itself. Iron(II) is oxidized to iron(III) on contact with oxygen in the air or by the action of iron related bacteria. Iron(III) forms insoluble hydroxides in water. Iron is generally present in organic waste and as plant debris in soil. Activities in the biosphere may have strong influence on the occurrence of the element in ground water. Higher iron concentration in the groundwater could from interaction between oxidized iron minerals and organic matter on dissolution of $FeCO_3$. This type of water is clear when drawn, but soon becomes cloudy and then brown by precipitation of $FeCO_3$ (Hem,1991), which is a common problem in some parts of the study area. The other reason of higher concentration of the element may be removal of dissolved oxygen by organic matter within the sediments leading reduced conditions. Under this condition the solubility of iron bearing minerals (Siderite/Marcacite) increases leading to enrichments of the dissolved iron in the groundwater . Enrichment of Fe in all the seasons indicates the biological cycle and consequent leaching from top to the groundwater. Some of the water samples have relatively higher iron concentration than the concentration of iron observed in the ground waters under the natural geogenic environmental conditions. These stations are located near by municipal waste waters. The municipal waste water contains organic matter. Organic content of municipal wastes with iron minerals present in the soil/weathered materials provides an environment favorable for reduction of ferric iron and gives rise to higher concentration of ferrous iron in the circulating groundwater (Hem 1991). This further supports the relatively higher iron content in the ground water affected by municipal waste waters.

Health disorders

Man cannot sustain without water. Hence, the water should be in potable way, following the standard limit (ISI 1983;WHO1984). The use of contaminated ground water is highly objectionable, as they cause health disorders. The reported health disorders in the study area are skin, digestive, respiratory and nervous systems, kidneys, spinal cord, heart, mental imbalance, miscarriage and cancer.

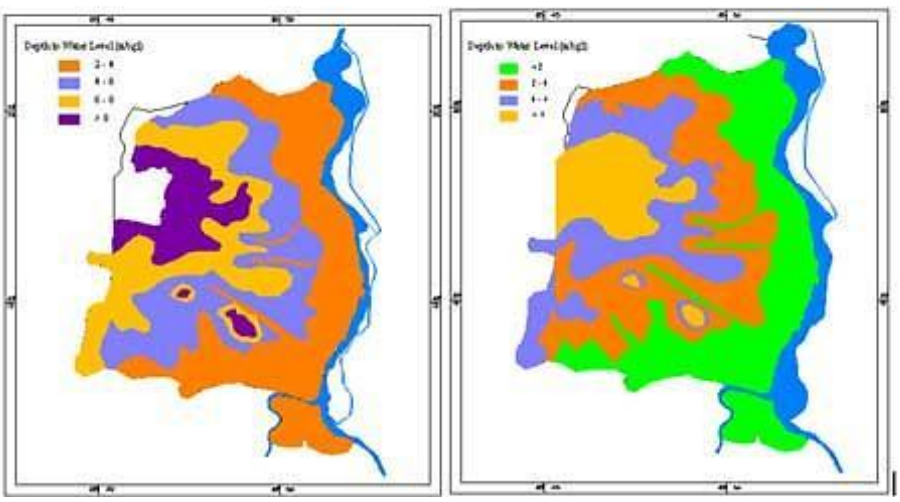
Management of groundwater quality

Management of groundwater quality is an important aspect before one can speak about aim of water quality control and improvement. Monitoring of water quality is of crucial importance, which is a part of water resources management, especially in an area where the people depend upon the ground water for drinking.
There is no ground water quality – monitoring network properly and systematically on regular basis for assessing the impact of pollutants on ground water system in the study area Hence, the present study emphasize the necessity of close monitoring of groundwater quality with reference to land use/land cover activities to protect the ground water resources from the pollution for sustaining life. In this context, environment awareness and education among the public are very essential for proper understanding about the water quality at different levels of management.

Conclusion

The present study carried out in Bhubaneswar city, Odisha to assess the causes for the origin and distribution of iron content in the ground water. Almost all the samples of Bhubaneswar contains heavy amounts of iron. It is due to the soil which is lateritic in nature. Another reason may be age old hand pump sets which require immediate replacement. Spatial distribution of iron content indicates that the higher concentration of iron is observed at locations near by municipal waste water due to inadequate sanitary facilities. This clearly suggests that the anthropogenic activities such as municipal waste water are masked the influence of geogenic processes. These factors degrade the ground water quality, which is a persistence of environmental problem in the study area. Hence, the pollution is the least checked perennial problem in the area. As a result, the concentration of iron in all the ground waters is more than the safe limit prescribed for drinking

Fig.1



Depth to Water Level, May Depth to Water Level, Dec

Fig.2

Table-02 Seasonal variation of iron content in different locations

	Winter-11	Summer-11	Rainy-11	Winter-12	Summer-12	Rainy-12
Location-01	0.33	0.38	0.32	0.35	0.39	0.36
Location-02	1.2	1.4	1.1	1.3	1.5	1.2
Location-03	3.7	4.1	1.1	1.3	1.5	1.2
Location-04	6.3	6.5	6.4	6.5	6.9	6.4
Location-05	5.2	5.6	5.1	5.4	5.5	5.3
Location-06	2.4	2.6	2.3	2.4	2.7	2.3
Location-07	4.9	5.0	4.8	5.0	5.2	4.9
Location-08	6.2	6.4	6.1	6.3	6.5	6.1
Location-09	7.5	7.7	7.3	7.5	7.6	7.4

purposes, causing the health disorders. The present study emphasized necessity of close monitoring of ground water quality with reference to land use/ land cover activities to protect the ground water resources from the pollution. We should take steps to remove iron from the ground water by aeration or by chemical dosing to comedown the iron level within stands i.e 0.3 mg/l.

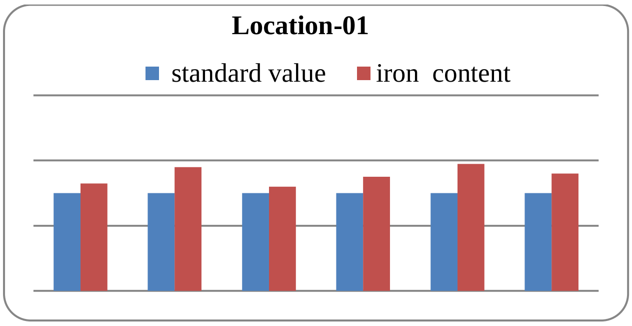


Fig-03

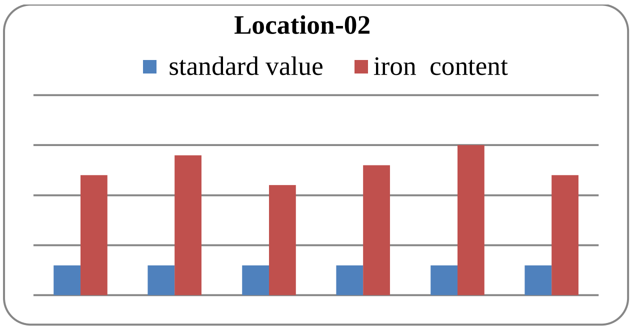


Fig-04

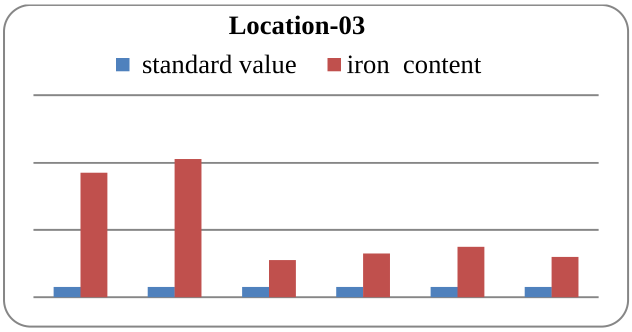


Fig-05

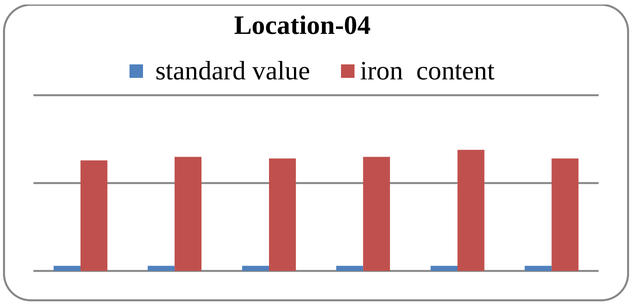


Fig-06

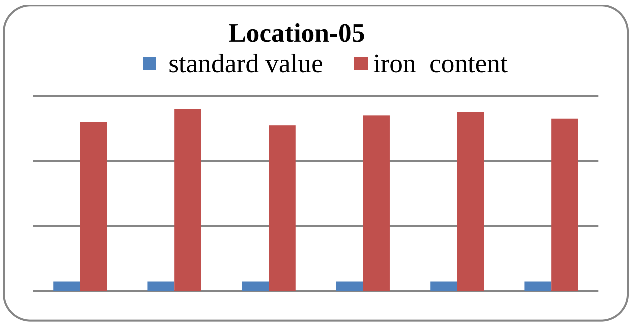


Fig-07

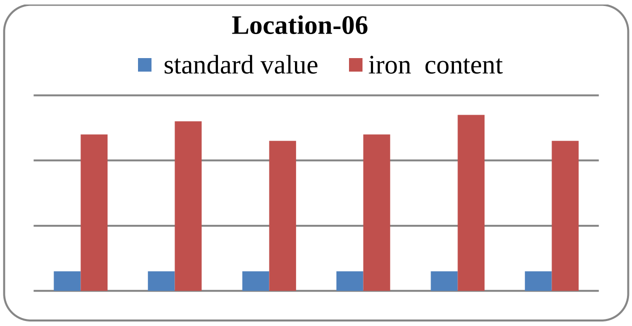


Fig-08

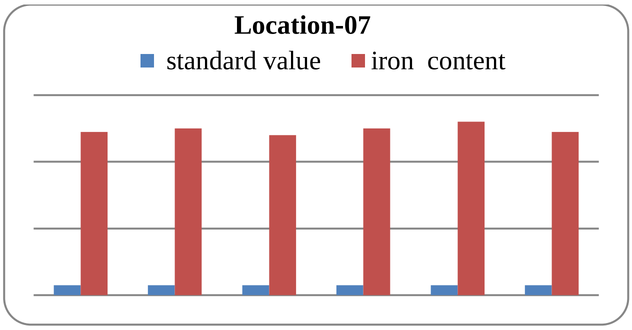


Fig-09

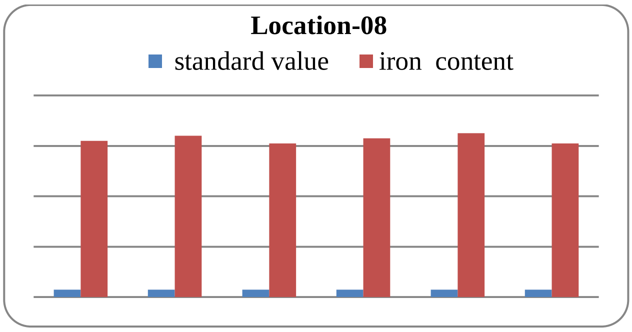


Fig-10

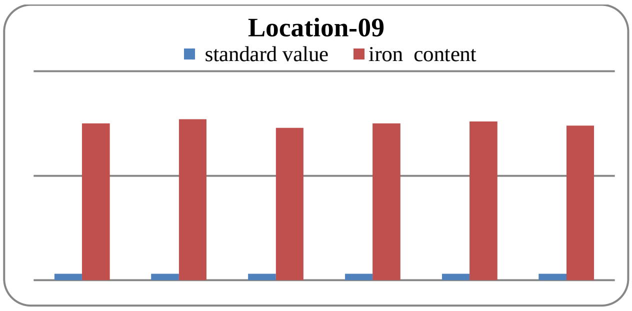


Fig-11

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