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Alteration of Water Quality Parameters Due to Iron Ore Mining in Keonjhar District, Odisha, India

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Abstract

Water is considered as one of the principal necessities of survival of life. We can't live without water. We get water from rivers, lakes, tanks, and springs and also from some ground water sources. In spite of abundance of water, there is a shortage of soft water in the world. Physico-chemical parameters of any water body play a major role in maintaining the fragile ecosystem that maintains different life forms. Odisha is one of the most mineral rich state of India and there are more than 26 type of mineral available in the state. Though mining is very beneficial to the industrial sector and is a positive indicator in terms of socio-economic growth of our country, but during the excavation and extraction of mineral ores leads adverse impact on environment and also create pollution in water bodies so related issues can't be denied. The study aims to assess true impact of pollutants generated from different mines of Keonjhar mining area of Odisha. Water samples were collected from nearby water bodies including both surface water and ground water. Different physicochemical parameter such as pH, electrical conductivity, total dissolved solid, total hardness, total alkalinity, calcium hardness, magnesium hardness, chloride content and total iron content of collected water samples were analysed. The results of this investigation suggested that, the overload of pollutants leads to hydrological pollution with increasing level of TDS, increasing iron concentration were founds which leads to health hazard of both plant and animal. Without iron people may experience Anaemia, fatigue or an increase in infection. Iron overload also lead to hemochromatosis which can cause damage to liver heart and pancreas..

Key words: physic-o-chemicals parameters, iron, mining

Introduction

Water is used by human beings for different purposes for survival of life. The uses of water can be categorized under domestic, irrigation and industrial heads. The quality requirements of water for these purposes are different and vary within certain limits. Since the surface water sources are limited and often polluted to large extent by external factors, more and more attention is being paid now a days to utilise groundwater. The Anandapur subdivision is the populous part of the Keonjhar district of Odisha. Though the Iron ore Super group forms the basement, thick alluvial cover in the floodplain of river Baitarani and its tributaries favour intense cultivation. Sporadic industrial units have come up keeping pace with rapid industrialization of the country. In view of increasing importance of use of water for different purposes, attempts have been made in the present work to study the quality of water and to evaluate the suitability of ground, surface waters of the Keonjhar district for different purposes.India’s iron ore reserves are around 13 billion tons including around 10 billion of

hematite ore and 3 billion tons of magnetite ore (Indian mineral year book,2006). Around fifty eight percent of these reserves are confined to the eastern part of India mainly in the state of Odisha and Jharakhand. The remaining ores are distributed in the state of Chhattisgarh, Madhya Pradesh, Karnataka and Goa. Jamda-Koiravally in the Sanghbhum Odisha iron ore hosts major hematite iron ore deposits in eastern India. Demand of iron ore for steel making has increased significantly. Heavy metals occur in the soil in soluble form and in combined state. However, only soluble, exchangeable and chelated metal species in soils are mobile and hence more available in water (Hector et.al. 2011).

Materials and methods

Geographical location

Keonjhar districts is highly rich in mineral resources &have vast deposit of iron manganese &chromium ores.Keonjhar is situated in the northern part of Odisha. It is bounded by Mayurbhanj, Balasore and Bhadrak District to the east, Jajpur District to the south, Dhenkanal, Anugul and Sundargarh District to the west, and West Singhbhum District to the north. Keonjhar District lies between 21º 1’ N to 22º 10’ N latitude and 85º 11’ E to 86º 22’ E longitude & the geographical areas is around 8303square kilometres.

Collection of samples

Water samples are collected from different sampling sites like surface water collected from nearby streams, rivers, ponds and ground water collected from nearby wells. The samples of water were collected from different locations in which each sample was collected in one litter plastic bottle which was rinsed with detergent and then rinsed with the sample to be collected at least three times and incubated at 27°C.

Analysis of physico-chemical parameters

The standard methods were used for analysing physico- chemical parameters and metal contents (total iron) in water. The analysis of different parameters of water was made by standard methods recommended by APHA, AWAA and WPCF (2005) and Trivedi and Goel (1984). Permissible limits for drinking water quality according to American Public Health Association (APHA), World Health Organisation (WHO), Indian Standard Institution (ISI), Central Pollution Control Board (CPCB) and Indian Council of Medical Research (ICMR) are compared in this paper. These are the methods used for test of water quality

Results and discussion

Mineral resources are very rich in Keonjhar districts and iron, manganese and chromium ores are found in large amount. About 30% of the district's total area is covered with tracts of dense forests. Keonjhar also contains one of the oldest rock formations in the world, which covers an area of 100 square kilometre. In this study, the results of physico-chemical parameters of water sample collected from that area are depicted below (Table- 1 to 3).

pH: pH is a measure of the acidic or basic (alkaline) nature of a solution. Hydrogen ion [H^+] activity in a solution determines the ph. pH range of 6.0 to 9.0 appears to provide protection for the life of fresh water fish and bottom dwelling invertebrates.

The pH values in ground water as well as surface water are mostly confined within the range of 7.0 to 8.1.The pH values of most of the samples are well within the limit i.e. 6.5 to 8.5 prescribed by BIS (1991) and WHO (1984) for various uses of water including drinking and other domestic supplies.

Electrical Conductivity: The measurement of electrical conductivity is directly related to the concentration of ionized substance in water and may also be related to problems of excessive hardness or other mineral contaminants. The conductivity value in both surface and the ground water samples varies from 107 to 458 µS/cm.

Total dissolved solid

In natural water dissolved solids consists mainly of inorganic salts such as carbonates, bicarbonates, chlorides, sulphates and nitrates of calcium, magnesium, sodium, potassium, iron etc. and a small amount of organic matter and dissolved gases. In the present study the values of total dissolved solids in the ground water varies from 58-1430 mg/L and surface water varies from 106-429 mg/L.

Only one ground water samples and three surface water samples were found above the desirable limit of 500mg/L but well within the maximum permissible limit of 2000mg/L. The TDS content at ground water is comparatively lower than the surface water. Therefore it may be concluded that there is more mineralization of surface water than the ground water.

Water containing more than 500mg/L of TDS is not considered desirable for drinking water supplies, where better water is not available we used highly mineralised water. For this reason, the desirable limit of water is 500mg/L and the maximum permissible limit is 2000mg/L has been suggested for drinking water (BIS, 1991).

TDS more than 500mg/L in water caused gastro intestinal irritation (BIS, 1991). No water samples of Keonjhar mining area cross the permissible limit but some water samples exceed the desirable limit. Although some peoples of that area used it in drinking purposes but it is not suitable for drinking.

Alkalinity

The presence of carbonates, bicarbonates and hydroxides are the main cause of alkalinity in natural waters. Bicarbonates represent the major form since they are formed in considerable amount from the action of carbonates upon the basic materials in the soil.

The alkalinity value in ground water varies from 44 to 214mg/L and in surface water varies from 56 to 244mg/L. The high alkalinity value at some locations may be due to the action of carbonates upon the basic materials in the soil.

Total hardness

The total hardness is the sum of concentration of alkaline earth metal cations present in the water. It is due to presence of calcium and magnesium ion in water. Calcium and Magnesium along with their carbonates, sulphates and chlorides make a water hard. A limit of 300 mg/L has been recommended for potable water (BIS, 1991).

Calcium hardness

Calcium hardness is an important component of the carbonic buffer system. It is also cycle through biotic and abiotic components of the ecosystems. Calcium hardness is originates from natural processes is a dissolvent of minerals which contains calcium and other sources such as industrial wastes and agricultural wastes but this is nontoxic. The desirable limit for calcium is 200mg/L (BIS, 1991). In study area the values of calcium in ground water ranges from 18 to 60mg/L and in surface water ranges from 40to 88mg/L.

Magnesium hardness

Magnesium hardness is an important component of total hardness. It is also cycle through biotic and abiotic components of the ecosystems. Magnesium hardness is originates from different processes such as mining activities, degradation of rocks etc . The desirable limit for magnesium is 30 mg/L (BIS, 1991). In study area the values of magnesium in ground water ranges from 12 to 28mg/L and in surface water ranges from 18 to 48mg/L.

Chloride

Chlorides are the inorganic compound resulting from the combination of the chlorine gas with metal. Some common chlorides include sodium chloride (NaCl) and magnesium chloride ($MgCl_2$). Chlorine alone as (Cl_2) highly toxic, and it is often used a disinfectant. When it combine with sodium, it becomes essential for life. Small amounts of chlorides are required for normal cell functions in plant and animal life.

The chloride content in water of the study area is quite low and varies from 7.7mg/L to 12.7mg/L. No samples in the study area crosses the desirable limit of 250mg/L (BIS, 1991; WHO, 1996).

Sulphate

The sulphate content in water generally occurs as soluble salts of calcium, magnesium and sodium. During infiltration of rainfall and ground water recharge the sulphate content changes significantly which mostly takes place from stagnant water pools and surface runoff water. The concentration of sulphate in the study area varies from 42 to 158mg/L with all the samples falling within the desirable limit of 200mg/L.

Nitrate

Nitrate content in drinking water is considered important for its adverse health effects. The occurrence of high levels of nitrate in ground water is a prominent problem in many parts of the country.

The nitrate content in Keonjhar area varies from 6 to 48mg/l with all samples falling within the desirable limit of 45mg/L(WHO, 1996 and BIS, 1991). As such the ground water of Keonjhar does not possess any nitrate hazard to humans. Nitrates are an effective plant nutrient and are moderately toxic.

Its concentration above 45mg/L may prove detrimental to human health. In higher concentrations, nitrate may produce a disease known as methamo-globinaemia (blue babies) which generally affects bottle fed infants, repeated heavy doses of nitrate on ingestion may also cause carcinogenic effect.

BOD

Temperature of both the ground water &surface water varied according to the climatic changes. The temperature of water places an important factor which influences the chemical, biochemical and biological characteristics of water body. Average value of temperature in surface water is 24^0c and for Ground water the value is 29^0c. The rise in temperature of water accelerates chemical reactions, reduces solubility of gases, amplifies taste and odour and elevates metabolic activities of organisms. The result shows that all the data of ground &surface water are within the desirable limit that is 3mg/lit.

COD

Chemical Oxygen demand is the amount of oxygen (O_2)required to stabilize organic matter determined by using a strong oxidant. The results shows that it is well within the permissible limit i.e.250mg/lit

DO

Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. From the surrounding air oxygen gets in to water by diffusion, by aeration (rapid movement) and as a waste product of photosynthesis. The total dissolved solids gas concentration in water should not exceed 110% (above 13-14 mg/l). Above this concentration level can be harmful to aquatic life. Fish in waters containing excessive dissolved gases may suffer from “gas bubble disease”;. Reason of death is, the bubbles or emboli block the flow of blood through blood vessels. External bubbles emphysema can also occur and be seen on fins, on skin and on other tissue. ‘Gas bubble disease’ affected the Aquatic invertebrate, but at levels higher than those lethal to fish. For good water quality adequate dissolve oxygen is necessary. The results show that all the data of DO value exceeds the permissible limit i.e.6 mg/L.

Heavy metals

The contamination of ground water by heavy metals has received great significance during recent years due to their toxicity and accumulative behaviour. These elements contrary to most pollutants & are not biodegradable.

Chromium (Cr):

The permissible limit for Cr in water is 0.05 mg/l. The values of Cr in four samples out of 10 were found within the desirable limits.

Iron (Fe)

The desirable limit for iron in water is 0.3 mg/l by WHO. Iron has been considered to be an essential trace element for human and animal health. In this present study one groundwater where iron is in the form of iron (II), concentrations will usually be 0.5–10 mg/litre. In water treatment plants concentration of iron in drinking-water are normally less than 0.3 mg/litre but may be higher in countries where various iron salts are used as coagulating agents and where cast iron, steel, and galvanised iron pipes are used for water distribution.

Conclusions

The results showed that physicochemical parameters of all the samples of surface and ground water is within the permissible limits, whereas values of total dissolved solids, total hardness, and some heavy metal contents like iron were found to be relatively higher than the desirable limits.The concentration of selected toxic metals in the waste water, being used for the irrigation purpose, was found to be satisfactory but not suitable for drinking purposes. There is no denying in the fact that mining plays a significant role in economic development of our country. Keonjhar is playing a significant role in fulfilling the domestic and world market demand of iron ore. Rather, there has been prominent environmental degradation due to depletion of its vast forest, land, water and air pollution affecting adversely the quality of life due to denial of access to food security, natural resources and-livelihoods.

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References

[1] F. M.Hector, R. M. V. Oscar, M. S.Enrique, C. O. B. Ma-Del and L. B. O. Ana. Heavy metals in agricultural soils and irrigation waste water of Mixquiahuala, Hidalgo, Mexico, African Journal of Agricultural Research, 6(24), (2011), 5505 – 5511.

[2]World Health Organisation WHO . Water for Health, WHO Guidelines for Drinking-Water Quality. Geneva: World Health Organisation; 2010.

[3] WHO (1984). Guidelines for drinking water quality. Recommendation World Health Organisation, Geneva. Volume 1, 130.

[4]Bresline E (2007) Sustainable water supply in developing countries. *GeolgclSocty of Amer*. Paper No. 1: 194

[5] National Academy of Science NAS . National Academy of Science: Overview-Safe Drinking Water is Essential. Washington, D.C: The National Academies Press; 2009.

[6]Ganesh K, Hedge KYS. Quality of lenetic waters of Dharwad district in North Karnataka. J Environ Health. 1995;7(1):52–56.

[7]MacDonald A M, &Calow RC (2009) Developing groundwater for secure rural water supplies in Africa. *Desalination*.

[8] APHA, AWWA and WPCF (2005). Standard methods for examination of water and waste water, 21 st edition, *American Public HealthAssociation, New York*.

[9] Trivedi, R. K. and Goel, P. K. (1984). Chemical and Biological methods for water pollution status. Environmental publication, Karad (India).

[10] BIS (1991). Indian standard for drinking water, Bureau of Indian standard, New Delhi, India, 1 -9, 179.

TABLE-1: Different sampling sites in and around Keonjhar area

Sl. No	**SAMPLING SITE**	**SAMPLE TYPE**
1	Anandpur village (well water)	Surface water
2	Joda Basudevpur village(well water)	Surface water
3	Joda Kundranallah village (well water)	Surface water
4	Deogaon (tube well water)	Surface water
5	Harichandanpur village (well water)	Ground water
6	Jhumpura village	Ground water
7	Saharapada area	Ground water
8	Mine discharge water at confluence of Ghasipura	Surface water
9	Mine dischaege water at Banspal	Surface water
10	Pond water near Champua	Surface water

TABLE-2 Different physico chemical parameters of ground water samples of selected sites of Keonjhar area

Sl.NO	PARAMETERS	UNIT	DESIRABLE LIMIT	GROUND WATER
1	pH	_	6.5-8.5	7.80-8.22
2	Electrical conductivity	µs/cm	>750-3000	85-656
3	Total dissolved solids	mg/L	500	58-1430
4	Alkalinity	mg/l	200	44-214
5	Total hardness	mg/L	300	20-275
6	Calcium hardness	mg/L	200	18-60
7	Magnecium hardness	mg/L	30	12-28
8	Chloride	mg/L	250	7.7-12.7
9	Sulphate	mg/L	200	32-154
10	Nitrate	mg/L	45	6-44
11	BOD	mg/L	3	0.4-2.8
12	COD	mg/L	250	1.8-7.1
13	DO	mg/L	6	7.7-8.4
14	chromium	mg/L	0.05	0.05-0.75
15	Total iron	mg/L	0.3	0.1-0.5

TABLE-3 Different physico chemical parameters of surface water samples of selected sites of Keonjhar area

Sl.NO	PARAMETERS	UNIT	DESIRABLE LIMIT	SURFACE WATER
1	pH	_	6.5-8.5	7.0-8.1
2	Electrical conductivity	µs/cm	750-3000	107-458
3	Total dissolved solids	mg/L	500	106-429
4	Alkalinity	mg/l	200	56-244
5	Total hardness	mg/L	300	74-134
6	Calcium hardness	mg/L	200	40-88
7	Magnecium hardness	mg/L	30	18-48
8	Chloride	mg/L	250	7.1-12.5
9	Sulphate	mg/L	200	42-158
10	Nitrate	mg/L	45	6-48
11	BOD	mg/L	3	0.9-2.1
12	COD	mg/L	250	1.8-8.85
13	DO	mg/L	6	7.1-6.4
14	Total chromium	mg/L	0.05	0.09-0.6
15	Iron	mg/L	0.3	0.44-1.75