IMPACT ASSESSMENT OF IRON ORE MINING ON WATER QUALITY IN AND AROUND MINING AREA - A CASE STUDY

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Abstract- *In the present study, an attempt has been made to find out the impact of iron ore mining on water quality in and around iron ore mine. The study was conducted in Sandur, Bellaray (dist.), Karnataka. Physico-chemical parameters like pH, turbidity, chloride total hardness, calcium, magnesium, total dissolved solids, total suspended solids, fluoride, alkalinity and biochemical oxygen demand investigated and then compared with permissible limits. Water samples were collected at five different locations of the mining area. The investigation revealed that all the parameters results at different locations are below the permissible limit, except the locations Krishna Nagar (GWK). Total hardness, total suspended solids and alkalinity parameters crossed the permissible limit and Muraripura (GWM) alkalinity reached the permissible limit and hence, preventive measures are required to avoid further deterioration of the water quality.*

Key Words: Water quality, Physico-Chemical Parameters, Permissible limit

1. INTRODUCTION

Modern mining is an industry that involves the exploration for and removal of minerals from the earth, economically and with minimum damage to the environment. Water pollution problems caused by mining include metal contamination and increased sediment levels in streams.

Water is one of the renewable resources essential for sustaining all forms of life, food production, economic development, and general wellbeing. But due to increased human population, industrialization, use of fertilizers in agriculture and man-made activity, it is highly polluted with different harmful contaminants. Therefore, it is necessary that the quality of water should be checked at even time interval because due to the use of contaminated water, the human population suffers from varied water-borne diseases.

India produces approximately 200 MT of iron ore per year, which is the primary raw material in the construction industry and allied industries. In reality, the rate of environmental impacts is also equally high. Many iron ore mines have been abandoned due to environmental degradation and hazards in mining areas which causes significant concern (Erraiyan, 2014). Iron ore has been extracted from vast reserves in chemical and classic rocks (sedimentary, igneous, and metamorphic) for many years. It is the primary ingredient for steel making. Iron is the fourth most excessive mineral in the earth's crust. The extensive mining activities also adversely affect the environment. Due to a lack of proper planning and regulations, an appreciable amount of environmental degradation and ecological damage to water, air, and soil occur.

An investigation was carried out to know the impact on surface water quality due to the disposal of tailings from iron ore mines in India. The study reveals that Kurhadi river water deteriorates due to the discharge of tailing pond effluent causing surface water pollution. For proper management of water pollution, recycling of decanted effluent is to be adopted for iron ore beneficiation plants (Ghose and Sen,1999). Regular monitoring of the quality and quantity of wastewater should be intensified (Rani et al., 2005). Environmental impact assessment studies were carried out in the iron ore mining areas of the Goa region using both qualitative and quantitative methods. From the qualitative approach, it was observed that surface excavations and solid waste disposal are more responsible for affecting the environmental parameters like soils, landforms, groundwater, surface water and flora (Venkatraman and Ratha, 2007).

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. It is necessary to know details about different Physico-chemical parameters such as color, temperature, Total hardness, pH, sulphate, chloride, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and alkalinity used for testing of water quality. The effects of water pollution are devastating to people and animals, fish, and birds also destroy aquatic life and reduce its reproductive ability. Polluted water is unsuitable for drinking, recreation, agriculture, and industry (Sagar *et al.*, 2015; Kale, 2016, Murthy *et al.*,2017)

Thus, estimation of the quality of water is essential for proper assessment of the associated hazards. The impact assessment of iron ore mining on water quality was conducted around iron ore mining in Sandur, Bellary dist. Karnataka.

2. MATERIAL AND METHODOLOGY

To analyze the particular effect of iron ore mining on water conditions, a case study on Iron ore mines, Sandur Taluk, Bellary district, Karnataka, has been selected. The inhalation of iron ore dust during mining may result in siderosis or welder's lung and catalyzes radicals that are injurious to biological molecules, cell, tissues, and organisms. Severe iron overload in water due to mining is detrimental to life, while protracted overload leads to slow or lethal damage to major organs like the heart and liver of organisms, but the overall damage that eventuates these organ failures is not thoroughly well-known. The mining lease area is situated on a hill range located in Muraripura village. The area falls in the NEB Range Forest. The drainage pattern is dendrite to sub dendrite, which is then joined together into the sub tributaries of the tank at Muraripura in the West and another at Krishna Nagar East. Second draining on the eastern side, north-west, and on the south-western side outside the lease area.

The method and procedure for obtaining soil samples vary according to the purpose of sampling. Analysis of water samples may be needed for engineering and agricultural purposes. In this publication, water sampling for engineering purposes is described, which is done for water quality evaluation. . The following points have been kept in mind while collecting water samples.

2.1 Sample Volume

The sample volume depends on the elements or substances required to be analyzed on their expected concentration in the sample.

2.2 Number of Samples

The number of samples required largely depends on the problem at hand. To get an average concentration, several samples are collected as per a general calculation of the necessary number of samples.

2.3 Storage and Conservation

To prevent any addition of contaminants, loss of determinants by sorption or other means, and any other unintended changes that affect the concentrations of determinants of interest, proper preservation carried out. For this purpose, long-term storage with little composition change must be preferred.

2.4 Sample Locations

Surface water samples collected at Krishna Nagar (SWK), Muraripura (SWM), and groundwater samples the near nursery of mines (GWN), Krishna Nagar (GWK), and Muraripura (GWM).

2.5 Physico-Chemical Assessment

Physico-chemical characterization of ground and surface water for pH, turbidity, chloride, hardness, calcium, magnesium, total dissolved solids (T.D.S).total suspended solids (T.S.S), fluoride values, total alkalinity, and biochemical oxygen demand (B.O.D). All parameters analyzed using standard methods.

3. RESULTS AND DISCUSSIONS

The statistical analysis of water samples collected from five locations were analyzed for all 11 parameters and given in Table 1(Anonymous, 1991; 1992).

Table 3.1: Laboratory Results of water Samples

SAMPLE LOCATION / PARAMETERS	SWK	SWM	GWK	GWN	GWM	PERMISSIBLE LIMITS OF WATER
pH	7.2	7.4	7.2	7.6	7.5	8.5
Turbidity (NTU)	8.1	5	5.8	2.7	2.1	10
Chloride (mg/l)	28	52	358	296	235	600
Total Hardness (mg/l)	61	180	641	352	581	600
Calcium (mg/l)	16	20	168	88	160	200
Magnesium (mg/l)	5	7	53	32	44	100
TDS (mg/l)	135	175	1545	990	1300	1500
TSS(mg/l)	48	28	4	3	2	100
Fluoride(mg/l)	0.18	0.3	0.15	0.18	0.18	1.5
Alkalinity(mg/l)	152	98	710	410	690	600
BOD(mg/l)	2	1.8	2.15	1.6	2.6	3

- NTU : Nephelometric Turbidity Units
- mg/l : milligram per liter
- SWK : Surface Water Krishna Nagar
- SWM : Surface Water Muraripura
- GWN : Ground water near nursery of mines
- GWK : Ground water Krishna Nagar
- GWM : Ground water Muraripur

3.1 pH in Water Samples

The pH is a key element in controlling the freshwater climate. The pH of the system depends directly on both chemical and biological reactions. pH values in drinking water contain trihalomethanes that can cause cancer in humans if they are used for a longer time and higher pH decreases the germicidal capacity of chlorine.

The results of pH in different locations are shown in Fig.1.1.Based on environmental standards, the permissible limit of pH is 8.5 (https://scclmines.com/env/Linkfile2.htm). The pH value of surface water samples at locations of SWK & SWM, groundwater at locations GWN, GWK & GWM are found to be 7.2, 7.4, 7.6, 7.2, and 7.6 respectively.

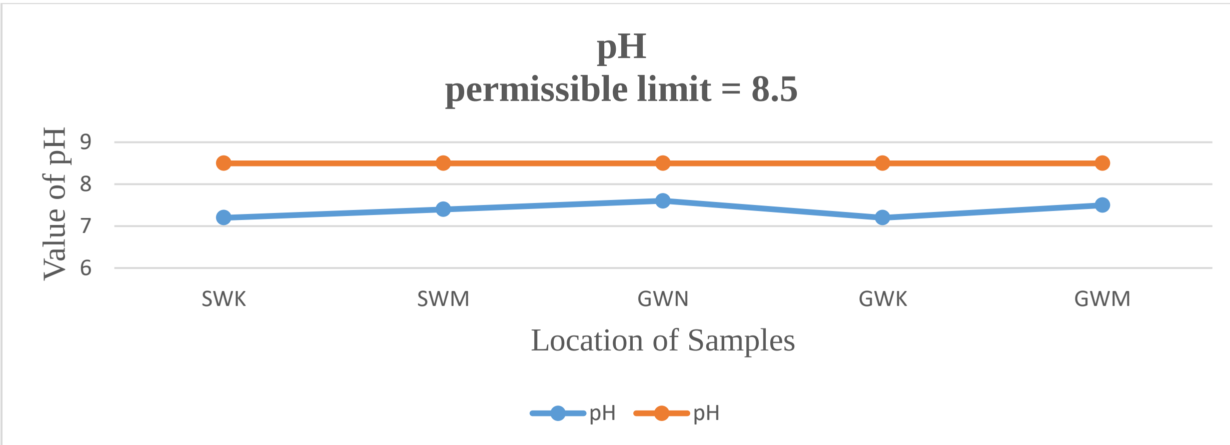

Fig. 3.1. pH in water samples

pH values in water samples of all locations of the study area vary from 6.5 to 8.2 and it shows that pH in water samples is below the permissible limit. Hence, it can be utilized for agriculture purpose.

3.2 Turbidity in Water Samples

High turbidity reduced the aquatic condition of lakes and streams and it can kill fish and other water life by reducing the amount of food, degrading and affecting the work of gills. The cost of water treatment for drinking and food production can be increased.

The results of turbidity in different locations are shown in Fig.1.2. Based on environmental standards, the permissible limit of turbidity is 10 NTU (https://scclmines.com/env/Linkfile2.htm). The turbidity values of samples surface water at locations SWK & SWM, and groundwater at GWN, GWK and GWM are found to be 8.1, 5, 2.7, 5.8, and 2.1 respectively.

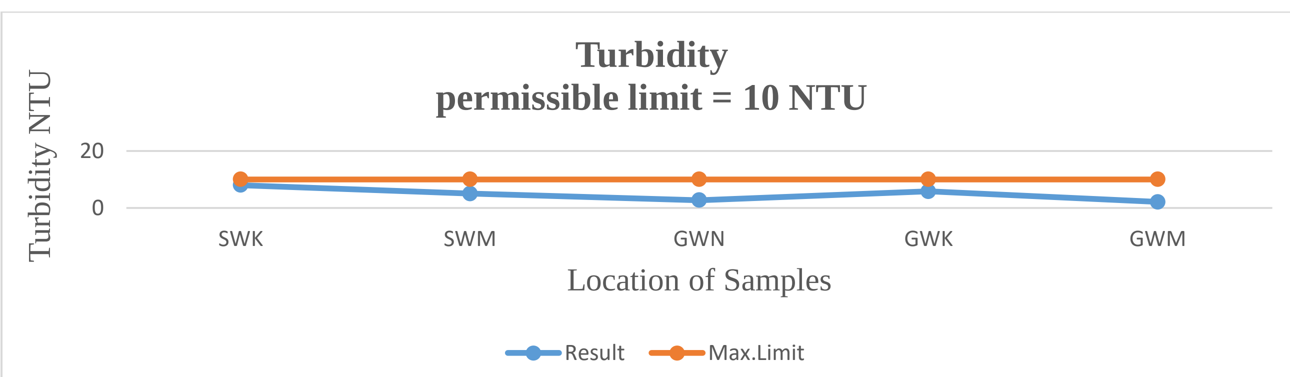

Fig. 3.2. Turbidity in water samples

Turbidity values in water samples of all locations of the study area varies from 0.3 to 8.1 and it depicts that turbidity in water is below the permissible limits and it is safe for the aquatic condition of lakes and streams as well as agriculture purpose.

3.3 Chloride in Water Samples

High levels of chloride in freshwater can damage aquatic species by disrupting osmoregulation, it difficulties can impede survival, development and reproduction.

The results of chloride in different locations are shown in Fig.1.3. Based on environmental standards, the permissible limit of chloride is 600 mg/l (https://scclmines.com/env/Linkfile2.htm). The chloride value of surface water samples at locations SWK & SWM, and groundwater samples at GWN, GWK and GWM are found to be 28, 52, 296, 358, and 235 respectively.

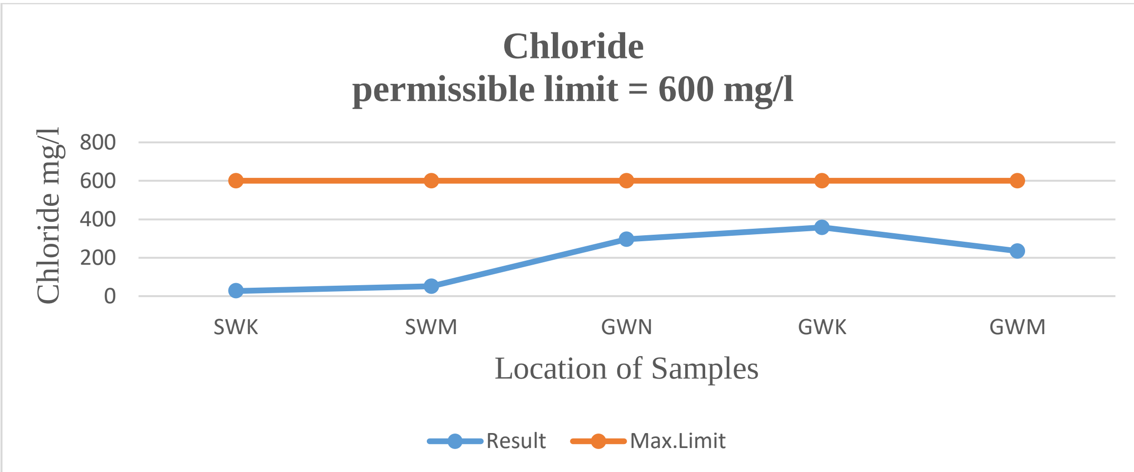

Fig. 3.3. Chloride in water samples

The chloride content in water samples of all locations of the study area varies from 12 to 358 and it depicts that all values are below the permissible limit. Hence it is safe for the aquatic condition of lakes as well as plant growth.

3.4 Total Hardness in Water Samples

The soft and hard water of the traditional potable water is tolerated by freshwater species. However, disease and death result as animals suddenly move from hard water to soft water. It is important to know in particular when integrating new animals into a system or moving these to other systems or facilities the hardness or softness levels of tank water in many animals.

The results of total hardness in different locations are shown in Fig.1.4. Based on environmental standards, the permissible limit of total hardness is 600 mg/l (https://scclmines.com/env/Linkfile2.htm). The total hardness values of surface water samples at locations of SWK & SWM and groundwater samples at GWN, GWK and GWM are found to be 61,180,352,641, and 581 respectively.

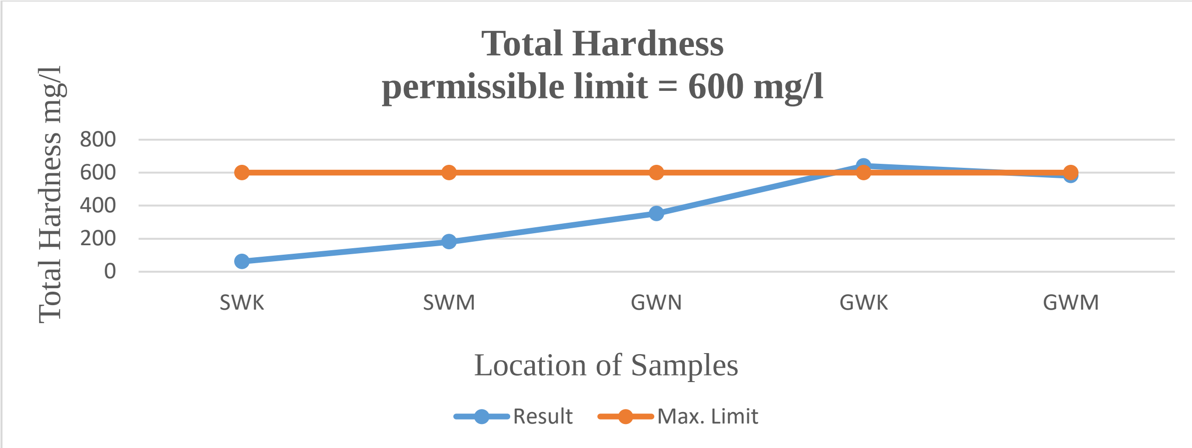

Fig. 3.4. Hardness water samples

Hardness values in water samples of all locations of the study area varies from 11 to 641. It shows that almost all locations have hardness below the permissible limits and only GWK-2 location have a high value i.e. 641. Hence according to total hardness, water cannot be safe for drinking and it can be utilized for agriculture purpose.

3.5 Calcium in Water Samples

The high deficiency of calcium in humans may cause rickets, poor blood clotting, bones fracture etc. and the exceeding limit of calcium produced cardiovascular diseases.

The results of calcium in different locations are shown in Fig.1.5. Based on environmental standards, the permissible limit of calcium is 200 mg/l (https://scclmines.com/env/Linkfile2.htm). The calcium values of surface water samples at locations SWK & SWM, and groundwater samples at GWN, GWK and GWM are found to be 16, 20, 88, 168, and 160 respectively.

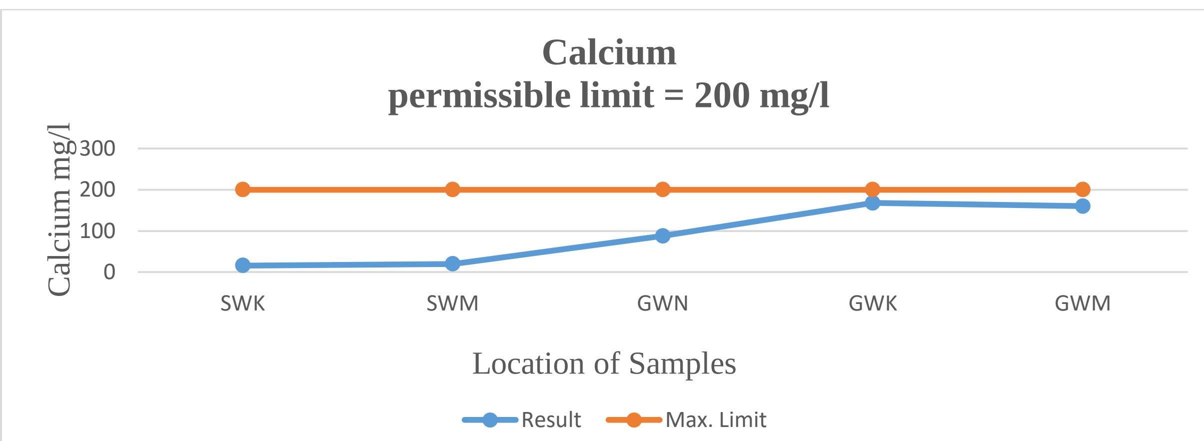

Fig. 3.5. Calcium in water samples

Calcium values in water samples of all locations of the study area varies from 3 to 168. It depicts that water in all locations has a calcium deficiency. Hence, water quality is not suitable for drinking purpose

3.6 Magnesium in Water Samples

Magnesium is essential for the proper functioning of living organisms and found in minerals like dolomite, magnetite etc. Human The human body contains about 25 g of magnesium (60 % in bones and 40 % in muscles and tissues).

The results of Magnesium in different locations are shown in Fig.1.6. Based on environmental standards, the permissible limit of Magnesium is 100 mg/l (https://scclmines.com/env/Linkfile2.htm). The magnesium values of surface water samples at location SWK & SWM, and groundwater samples at GWN, GWK and GWM are found to be 5, 7, 32, 53, and 44 respectively.

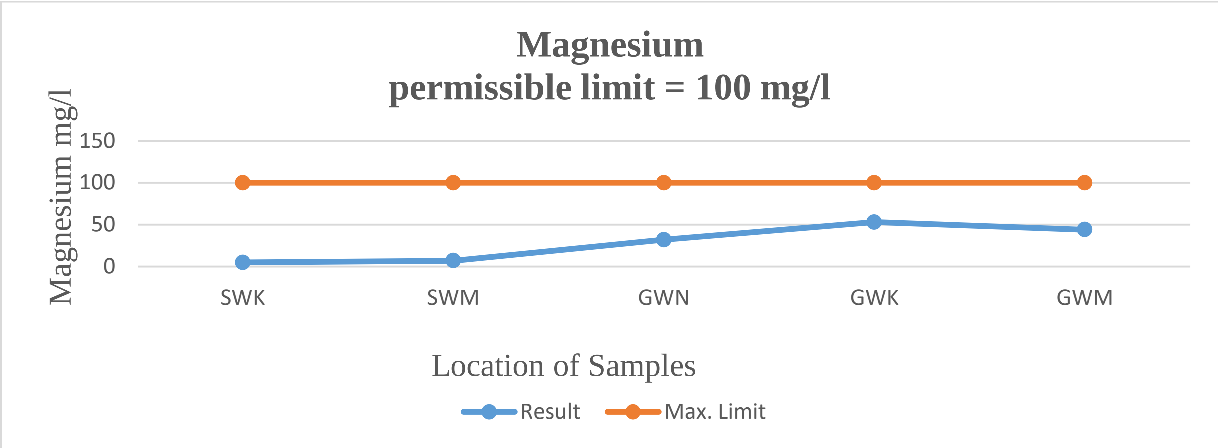

Fig. 3.6. Magnesium in water samples

Magnesium values in water samples of all locations of the study area varies from 1 to 53. It depicts that magnesium values are below the permissible limits i.e. all locations have Mg deficiency.

3.7 TDS in Water Samples

The water with a high TDS value indicates that water is highly mineralized. High values of TDS in groundwater are generally not harmful to human beings, but the high concentration of these may affect persons who are suffering from kidney and heart diseases. Water containing high solid may cause laxative or constipation effects (Sasikaran et al. 2012).

The results of Total dissolved solids in different locations are shown in Fig. 1.7. Based on environmental standards, the permissible limit of Total dissolved solids is 1500 mg/l (https://scclmines.com/env/Linkfile2.htm). The TDS values of surface water samples at locations SWK & SWM, and groundwater samples at GWN, GWK and GWM are found to be 135, 175, 990, 1545, and 1300 respectively.

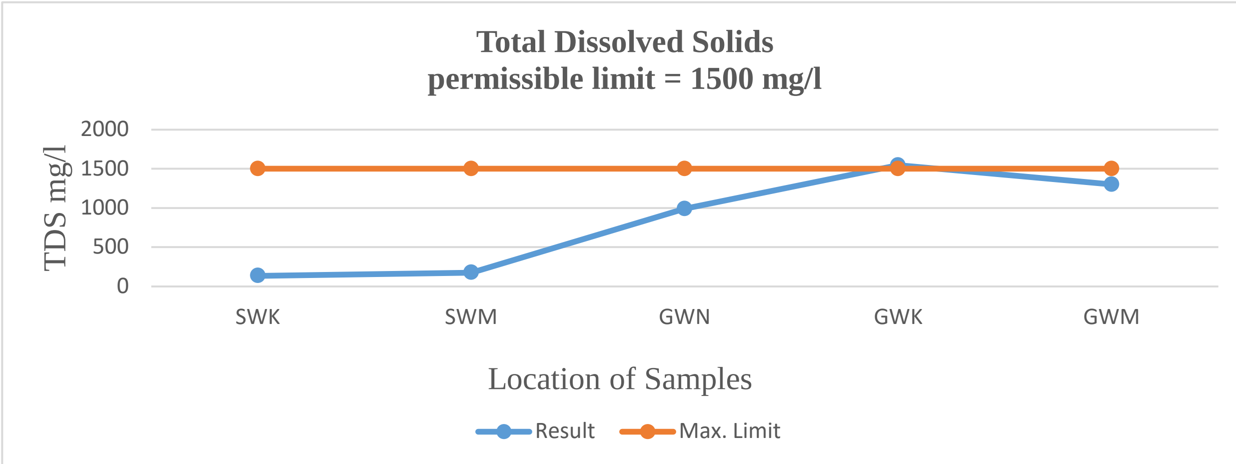

Fig. 3.7. TDS in water samples

TDS values in water samples of all locations of the study area varies from 45 to 1545. It shows that almost all locations water samples have TDS values below the permissible limits except GWK area. Hence, all locations water samples is safe for utilizing agriculture purpose and plant growth.

3.8 TSS in Water Samples

Total suspended solids are solids in water that can be trapped by a filter. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life.

The results of Total suspended solids in different locations are shown in Fig.1.8. Based on environmental standards, the permissible limit of Total suspended solids is 100 mg/l (https://scclmines.com/env/Linkfile2.htm). The TSS values of surface water samples at locations SWK & SWM, and groundwater samples at GWN, GWK, and GWM are found to be 48, 28, 3, 4, and 2 respectively.

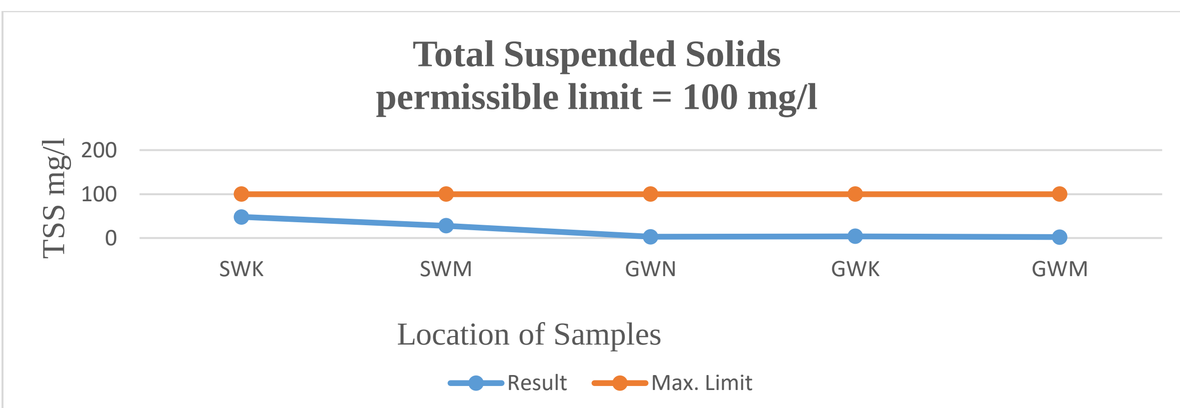

Fig. 3.8. TSS in water samples

TSS values in water samples of all locations of the study area varies from 1 to 48. It shows that all values are below the permissible limits. The highest value of 48 mg/l was found in water samples from the SWK-1 area. However, it is still well below the maximum standard limit of 100 mg/l.

3.9 Fluoride in Water Samples

Low concentrations provide protection against dental caries, especially in children. The pre and post-eruptive protective effects of fluoride increase with concentration up to about 2 mg of fluoride per litre of drinking water the minimum concentration of fluoride in drinking water required to produce it is approximately 0.5 mg/l. Fluoride can also have an adverse effect on tooth enamel and may give rise to mild dental fluorosis at drinking-water concentrations between 0.9 and 1.2 mg/l (Dean, 1942).

The results of Fluoride in different locations are shown in Fig. 1.9. Based on environmental standards, the permissible limit of Fluoride is 1.5 mg/l (https://scclmines.com/env/Linkfile2.htm). The fluoride values of surface water at locations SWK & SWM, and groundwater samples at GWN, GWK, and GWM are found to be 0.18, 0.3, 0.18, 0.15, and 0.18 respectively.

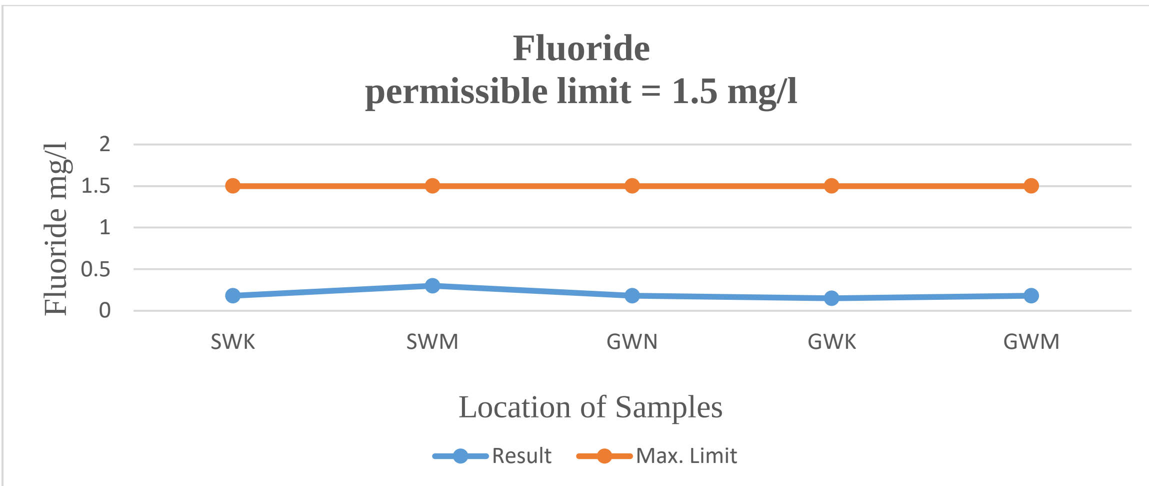

Fig. 3.9. Fluoride in water samples

Fluoride content in water samples of all locations of the study area varies from 0.1 to 0.29. It depicts that all values are below the permissible limits and it may not be harmful to human health. Hence, according to fluoride content water quality of the study area is safe for drinking as well as for agriculture purpose.

3.10 Alkalinity in Water Samples

Higher alkalinity levels in surface water buffer acid rain and other acid wastes, preventing pH changes that are harmful to aquatic life. Alkalinity is also important considering the treatment of wastewater and drinking water because it influences cleaning processes such as anaerobic digestion. Water may also be unsuitable for use in irrigation if the alkalinity level in the water is higher than the natural level.

The results of Alkalinity in different locations are shown in Fig. 1.10 based on environmental standards, the permissible limit of Alkalinity is 600 mg/l (https://scclmines.com/env/Linkfile2.htm). The alkalinity values of surface water at locations of SWK & SWM, and groundwater samples at GWN, GWK and GWM are found to be 152, 98, 420, 710, and 690 respectively.

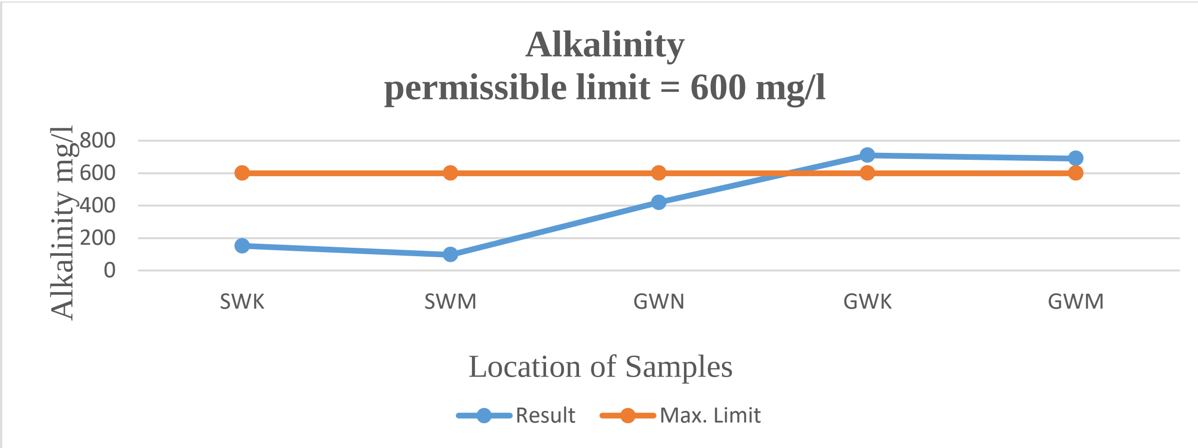

Fig. 3.10. Alkalinity in water samples

Alkalinity content in water samples of all locations of the study area varies from 18 to 710. It shows that water samples almost at all locations alkalinity values are below the permissible limit except two locations GWK-2 and GWM-2 area exceeds the permissible limits. Hence water quality of these two areas are not useful for irrigation.

3.11 BOD in Water Samples

BOD usually give an estimate of organic pollution in water and wastewater and used to measure the efficiency of most wastewater treatment facilities. Surface water is expected to have low BOD values to sustain aquatic life. High levels of BOD can cause harm to aquatic life, especially fish. Low levels of BOD in the river system indicate good water quality, while high levels indicate polluted water.

The results of biochemical oxygen demand in different locations are shown in Fig.1.11. Based on environmental standards, the permissible limit of biochemical oxygen demand is 3 mg/l (https://scclmines.com/env/Linkfile2.htm). The BOD values of surface water samples at locations SWK & SWM, and groundwater samples at GWN, GWK and GWM are found to be 2,1. 8, 1.6, 2.15, and 2.6 respectively.

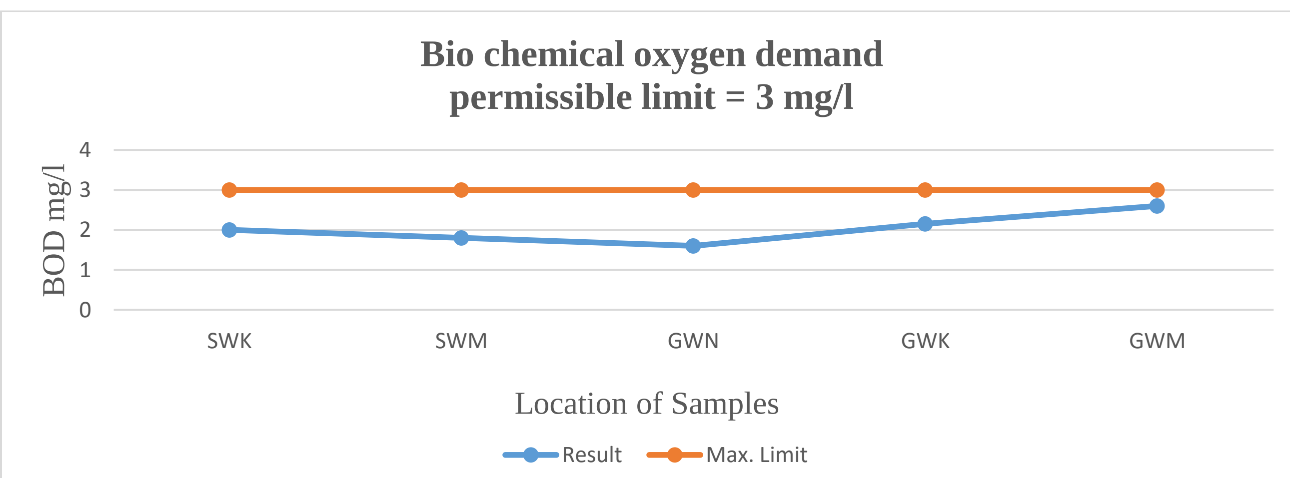

Fig. 3.11. BOD in water samples

BOD values in water samples of all locations of the study area varies from 1 to 26. It shows that BOD at all locations of the study area is below the permissible limits. Hence, water quality at all locations are good and safe for irrigation & aquatic life.

4. IRON ORE MINING IMPACTS ON WATER QUALITY

Estimation of the quality of water is significant for proper assessment of the associated hazards. The extensive mining activities also adversely affect the environment. Water pollution is due to the washing off and discharges of mine water from the mining area to the surrounding area. In order to assess the impact of iron ore mining on the water quality of the surrounding area, a study has been carried out in and around the mining area.

The water quality parameters studied for the surface water and groundwater. At five locations in the study area, the results of parameters in surface water found within the desirable limits. Only hardness, TDS, alkalinity exceeded the prescribed maximum limit in groundwater. High TDS values in groundwater are generally not harmful to human beings, but a high concentration of these may affect persons suffering from kidney and heart diseases. Higher alkalinity levels in the water will buffer acid rain and other acid wastes, preventing pH changes that are harmful to aquatic life. The water contamination is therefore still in the non – hazardous range. However, care should be taken in the future to maintain the desired concentrations of contaminants well below the hazardous level.

5. CONCLUSIONS

The impact assessment of iron ore mining on water quality carried out in and around iron ore mine Sandur, Bellary, Karnataka and following conclusion have been drawn:

- pH, turbidity, chloride, calcium, and magnesium, total suspended solids, fluoride, and biochemical oxygen demand values found below the level of permissible limit for different water samples collected in and around the iron ore mining area.
- The alkalinity content in groundwater of all locations found below the standard limit except Muraripura and Krishna Nagar-2. Hence, the water quality of these two areas are not useful for irrigation.
- Total hardness and TDS content of groundwater in all locations found below the standard permissible level except Krishna Nagar- 2 Location of the study area. High TDS value is groundwater is generally not harmful to human beings but a high concentration may affect persons suffering from kidney and heart disease.
- The physicochemical characteristics of water from a valuable tool for further ecological assessment and ecosystem monitoring. The effects of water pollution devastating to people and animals. Also, destroy aquatic life and reduce its reproductive ability. Polluted water is unsuitable for drinking, recreation, agriculture and industry.

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