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# Evaluation of heavy metal concentration in surface water bodies around mining areas at Kolayat, district Bikaner Northwestern Rajasthan, India

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## Abstract

*Traditional surface water resources like Talav, Nadi, Johad, Baori, Sarovar, Bandha etc. meet out the demand of drinking water in rural areas of western Rajasthan. Mining and its allied activities may affect the standards of surface water in the adjoining areas. Present investigation has been carried out in opencast mining and non-mining affected areas of Kolayat district Bikaner western Rajasthan for heavy metal evaluation in surface sources of water. During monsoon season sixteen samples of surface water sources of study area were collected by standard methods and evaluated for Iron, Manganese, Copper and Zinc by Atomic Absorption Spectrophotometer method and Sodium and Potassium by Flame photometer. The analyzed results were interpreted and compared with BIS of drinking water. Analysis of results and data interpretation reveals that the heavy metal assemblage in surface water sources of study area are below the recommended limit of drinking but mining affected areas have higher concentration than non-mining areas. Hence it is suggested that the mining and related activities in study area should be properly planned and not to disturb the natural drainage system of local talav, nadi, johad, sarovar etc. So that the water of surface bodies could maintain its quality for drinking purpose of local peoples. It is our duty to preserve and protect to natural resources of water for better future of coming generations and for humanity.*

**Keywords:** Assessment, drinking, heavy metals, mining, non-mining, surface water.

## Introduction

Nadi, talab, johad, bandha, baori, tanka, beri and sarovar are very important traditional water resources system in western Rajasthan. These traditional methods of surface water storage meet the water demands in the rural areas of western Rajasthan. Mining and its related activities of minerals especially Lignite, Clay, Fullers earth and Gypsum at surroundings of Kolayat region of Bikaner district are on extremity. Owing to opencast method of mining in the area physiography and surroundings are disturbed and water quality of surface bodies and underground sources are also deteriorating. Water is the basic necessity of human being and is a major natural resource.

There is need to make a proper planning, development and management to save water resources of terrain[1].Indira Gandhi canal water and ground water is mainly utilized for irrigation and drinking purposes in the district, but surface water during rainy to winter season also the sole source of drinking and irrigation for local people of village's at Kolayat region[2]. Mine wastes and dumps are filled across the natural drainage and catchment may affect the water quality of surface bodies by adding salts and other contaminations during flow through rain water to the water bodies[3]. Local people are using surface water for their needs and cattle's are also get water from these sources.

Present study is an attempt to evaluate the heavy metals concentration for Fe, Mn, Cu, Zn along with Na and K ions in bodies of surface water at mined and non-mined areas around Kolayat block of Bikaner district.

## Materials and methods

**Study area:** Bikaner district makes the central part of the Great Indian Thar Desert and lies in the Northwestern part of Rajasthan. The present study area is situated about 50km SW of district headquarter (Figure-1). The rock sequences exposed here are mainly tertiary sediments and are part of Bikaner-Nagaur basin. Subsurface data indicates that the Tertiary sequences are extended up to Karnapur area of Ganganagar district.

**Sample collection:** During monsoon season the surface water sources filled with rain water in catchment areas. Forthwith a total of 16 water samples, 8 from minerals mined out areas and 8 from non-mined areas were collected in clean pet water bottles of one liter bottle as per standard recommendation (WHO, 1993) of water quality presented in sample location map (Figure-2). Surface water bodies like Talav, Nadi, Johad and Baori occupied water from their catchment area during rainy season. Collected rain water in the mining pits, channels, trenches percolate in to sub surface with many contaminations.

**Methodology:** The standard methods for analyses of water samples like sampling, preservation, digestion and preparations are made as prescribed[4]. To avoid precipitation and to preserve metals add 5ml of concentrate nitric acid to samples and filtered by Whatman No. 42 filter paper. The organic impurities were removed by concentrated $HNO_3$ to check interference in analyses. 10ml of $HNO_3$ was added to 100ml of water in a 250ml conical flask and evaporate this mixture to half its volume on a hot plate then cools it and filtered. Then water samples were analysed for concentration of heavy metals like iron, manganese, copper and zinc by Atomic Absorption Spectrophotometer (AAS-Varian-880) and sodium and potassium ion by Flame Photometer (ESICO) Model 1381[5].

## Results and discussion

The analyses result of water samples of surface bodies of mined out and non- mined out areas are presented in Table-1. The analyses results reveals that the samples of mining affected areas have higher concentration of heavy metals like Fe, Mn, Cu, Zn, and Na and K than the samples of non-mining affected areas.

The adoption of unscientific mining methods, extensive land transformations, scattered waste dumps, uncongenial land use causes land derogation, loss of natural beauty and aesthetic values, pollution of soil, water resources and airborne in the area. Due to extreme pollution water sources also getting contaminated and deteriorate the quality.

Removal of top soil, unmannered quarrying, and generation of dust and dumps of waste across the nallah and in catchment of water bodies may affect the water quality (Figure-3). Haphazard use of pesticides and fertilizers in agriculture contains constituents of heavy metals, various activities of human being like mining, untreated industrial waste disposal to water sources causes deterioration in water quality furnish serious environmental problems to human being and aquatic biodiversity[6,7]. The behavior of human being influenced by the heavy metals impede mental and neuro function strikes neurotransmitter production and affect various metabolic activities of human body[8]. The analyzed results of heavy metal concentration in the bodies of surface water around mined out and non- mined out areas at Kolayat are discussed as follows-

**Iron:** Iron is the fourth most abundant element in the earth's crust which makes about 5.8 percent of crustal abundance and the most abundant heavy metal. The BIS drinking water standard is 0.3ppm desirable for iron, which can be extend up to 1ppm. In present investigation the iron concentration varies from 0.02ppm to 0.08ppm in non-mining areas and 0.12 to 0.22ppm in mining areas (Figure-4). The result shows that iron concentration in water samples are less than the permissible limit of drinking standard. The presence of iron in natural surface water bodies can be attributed to the weathering of rocks and minerals, landfill leachates, sewage effluents and other iron-related industries. In human body due to deficiency of iron anemia is caused and high iron content defect the organs like liver, kidney and cardiovascular system also[9]. Iron plays vital role in respiration, photosynthesis and production of healthy green leaves of plants. Due to iron deficiency plants suffer from chlorosis and stunted growth[10].

**Manganese**: According to the Bureau of Indian Standard, the desirable limit for manganese is 0.1ppm, which may extend up 0.5ppm for drinking purposes. The analyzed results for water samples for Mn shows the range of from 0.006 to 0.026ppm for non-mining areas samples and 0.01ppm to 0.056ppm for mining area samples which reveals that values are under the permissible limit (Figure-5). Manganese is an essential cofactor in enzyme activities and metabolic processes. Higher concentration of Mn in human body makes lethal and may leads to neurologic disorders[11].

**Copper:** Copper is an essential micronutrient of human body[12,13]. The analyzed results for water samples for Cu shows the range of 0.06 to 0.14ppm for non-mining areas samples and 0.13pp to 0.18ppm for mining area samples (Figure-6). BIS drinking water standard desirable limit for coppers is 0.05ppm, which may be extend up to 1.5ppm. The Cu concentration in water samples shows somewhat higher than desirable limit[14]. Copper is an essential trace mineral necessary for survival of human being. It is found in all body tissues and play important role in production of red blood cells and maintains neuro and immune system. Copper maintain the mental retardation, hypothermia, neutropenia, diarrhea, cardiac hypertrophy, bone fragility, impaired immune function, impaired central-nervous-system (CNS) functions, peripheral neuropathy, and loss of skin, fur (in animals), or hair color[15-18]. Hence copper is an essential element for life and health, its deficiency or excesses may cause adverse effects to the body.

**Zinc:** The present study shows the zinc concentration in water samples are from 1.8ppm to 5.8ppm which under permissible limits (Figure-7). The maximum desirable limit of Zn is 5.0ppm allowing to BIS drinking water standard, which may be extended up to 10ppm. The higher concentration of Zn causes gastrointestinal problems like abdominal pain, vomiting, diarrhea, anemia and renal damage. Higher concentration of Zinc in body can damage the pancreas and may disturb the protein metabolism[19].

**Sodium:** Sodium (Na) is the major cation that occurs in water. Weathering of igneous rocks releases the soluble product are the main source of sodium in natural water. The concentration of sodium in the non-mining area varies from 9 to 13mg/l and 13 mg/l to 53mg/l in mining areas. The WHO prescribed the maximum permissible limit of sodium is 200ppm. In our study area sodium concentration under the permissible limit. Higher concentration of sodium causes severe health issues like hypertension, heart and kidney problem[20].

**Potassium:** Granite rock is the main source of minerals potassium in feldspar, microcline, leucite and biotite etc. Weathering of these minerals may leads to K concentration in water bodies. The actions of K is normally same as Na content in water however its concentration is too low than sodium in surface water. Potassium maintained the fluid balance of the human body. The excess amount of potassium present in the water sample may lead nervous and digestive disorder[21]. It is one of the essential macro minerals for plant survival. In present investigation potassium concentration are ranged from 4 to 8 mg/l for mining affected areas and 3 to 18mg/l for mining areas (Figure-9). All the samples have potassium concentration in permissible limit. Potassium is an important constituent of animal fodders, soil fertility and plant development as well.

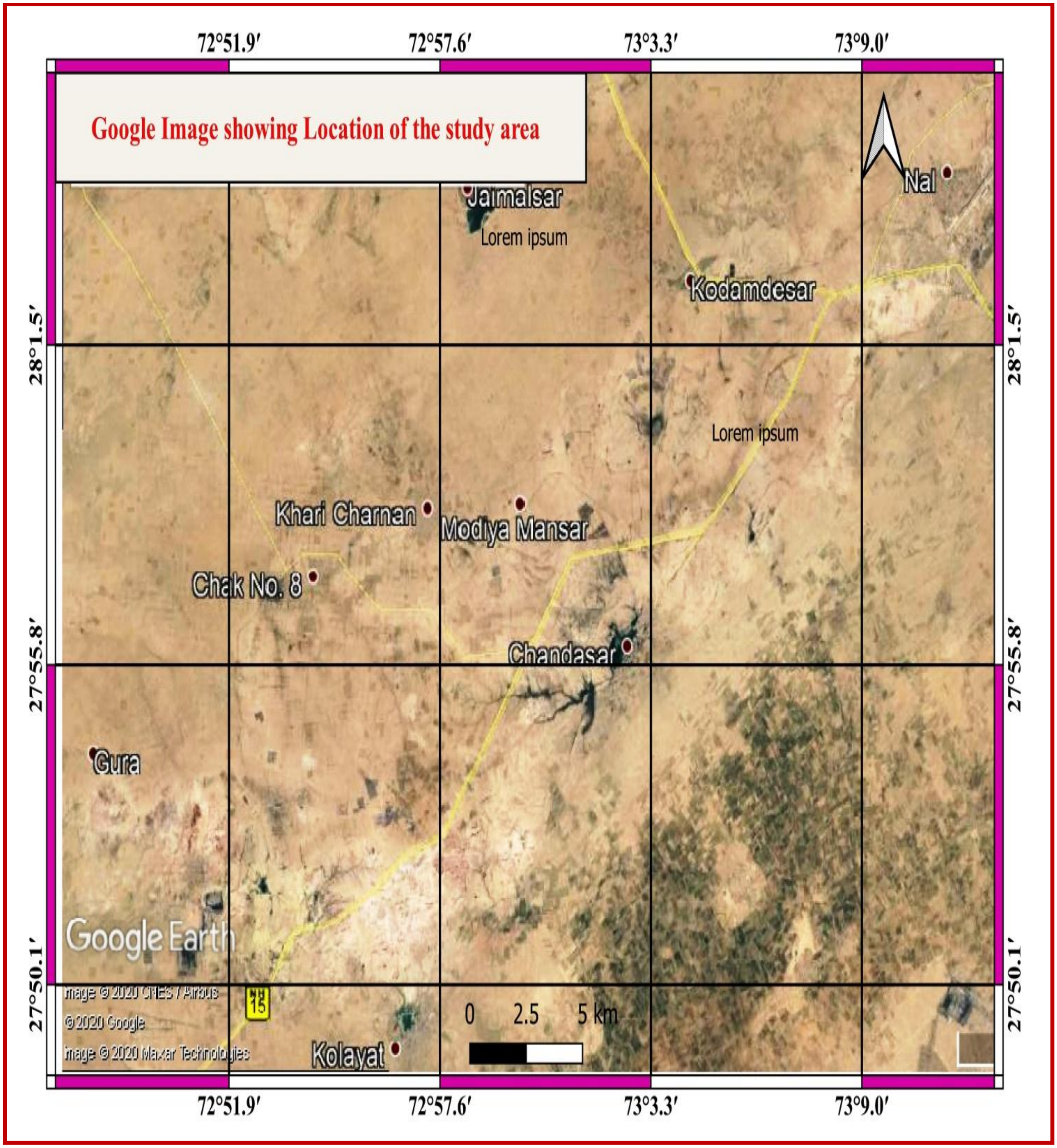


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**Figure-1***:* Showing Location of study area in Google map.

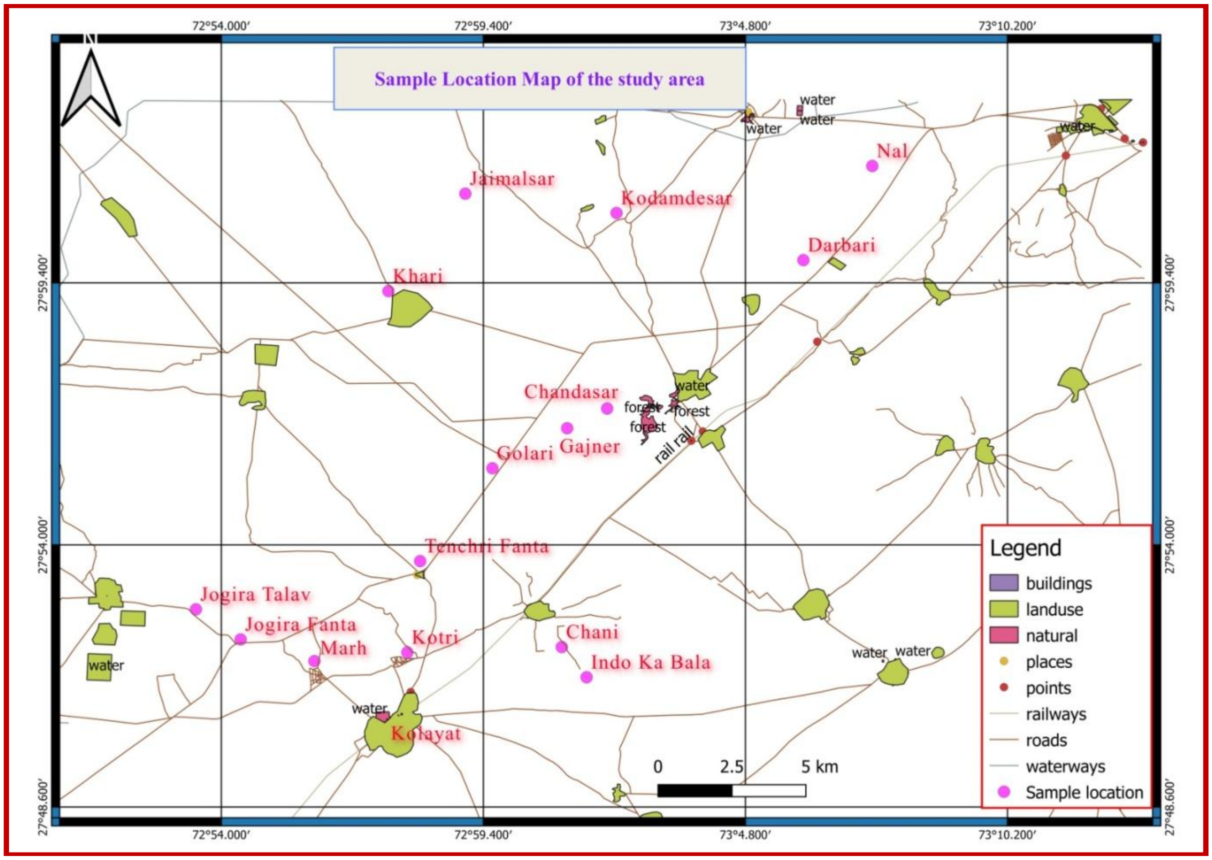


**Figure**-2*:* Showing sample locations map of the study area.


**Figure-3:** (a) whitish water in a quarry at Kotri. (b) dustry water in Jogira talab, (c) Whitish feculent water in treeh at Gurha Fanta, (d) Waste dump near nalla at Kotri.

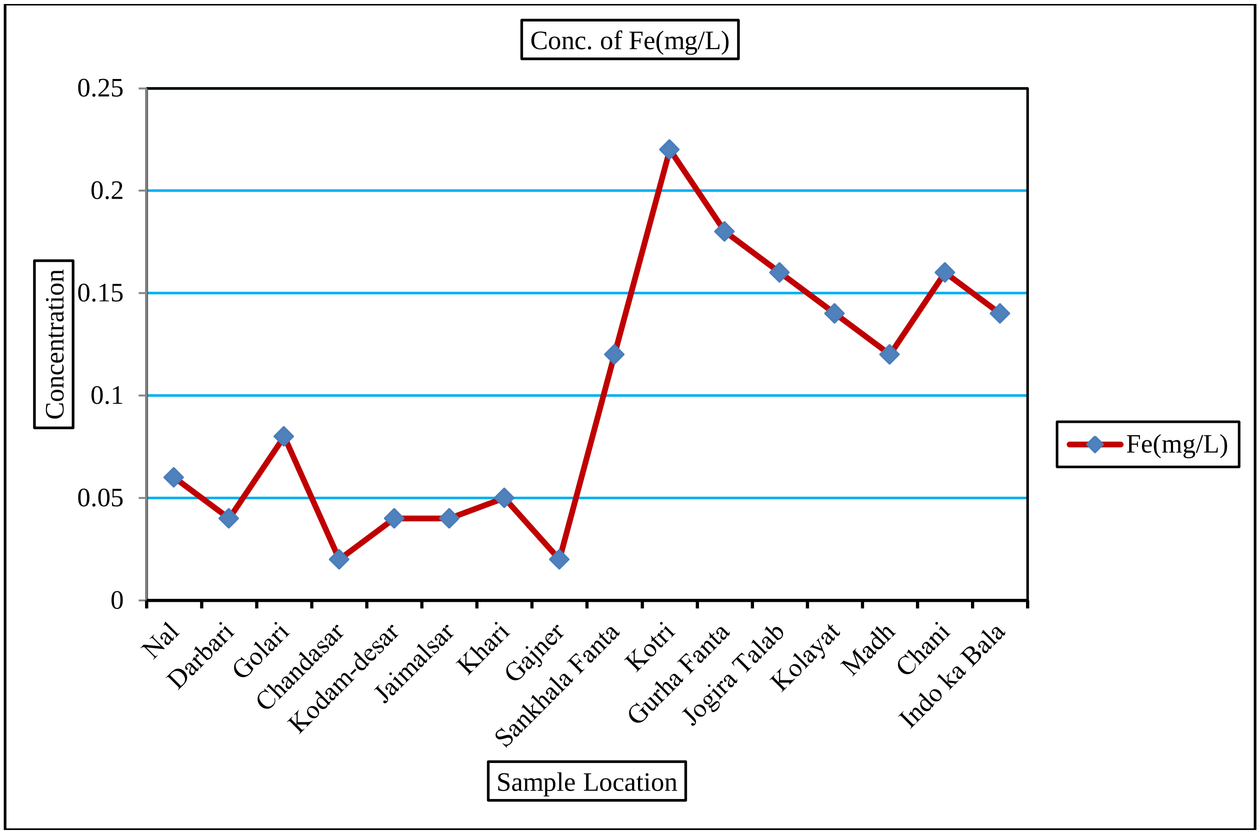


**Figure-4:** Showing concentration of Fe in surface bodies water samples of study area.

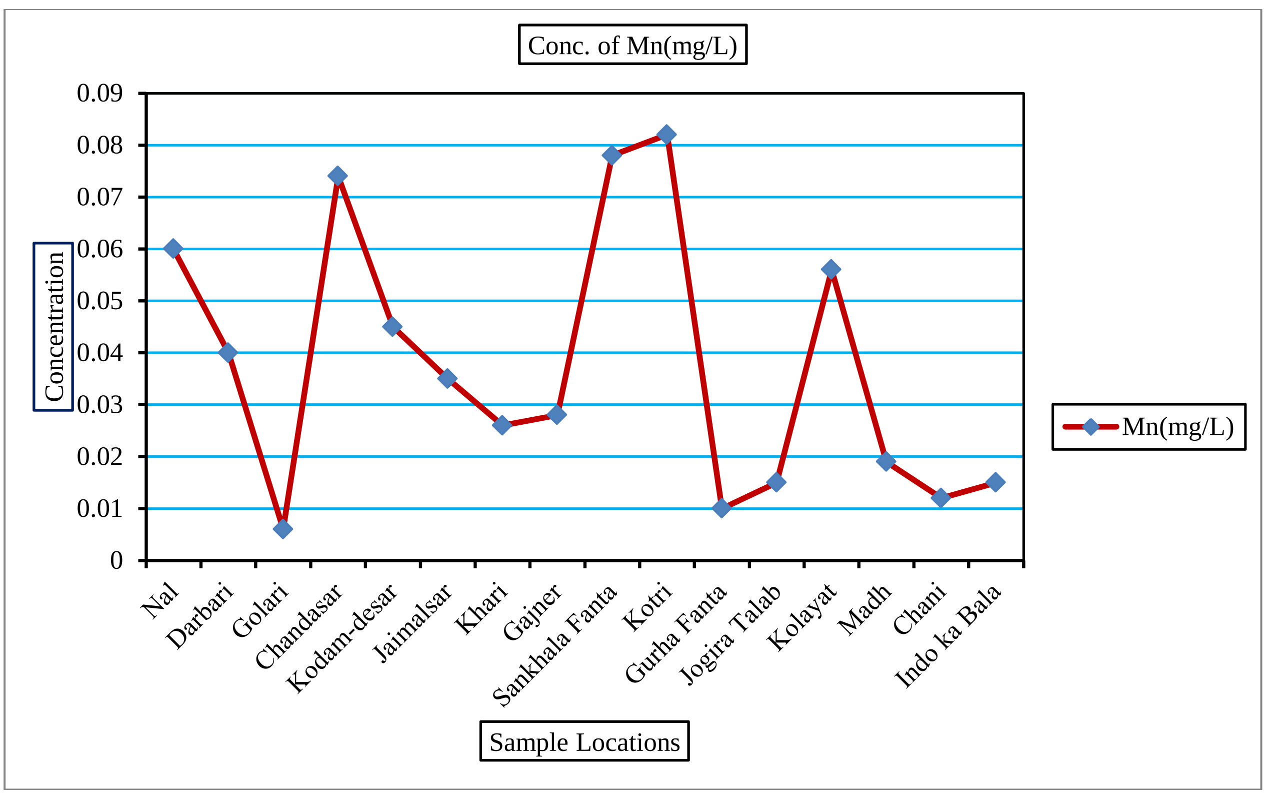


**Figure-5:** Showing concentration of Mn in surface water bodies samples of study area.

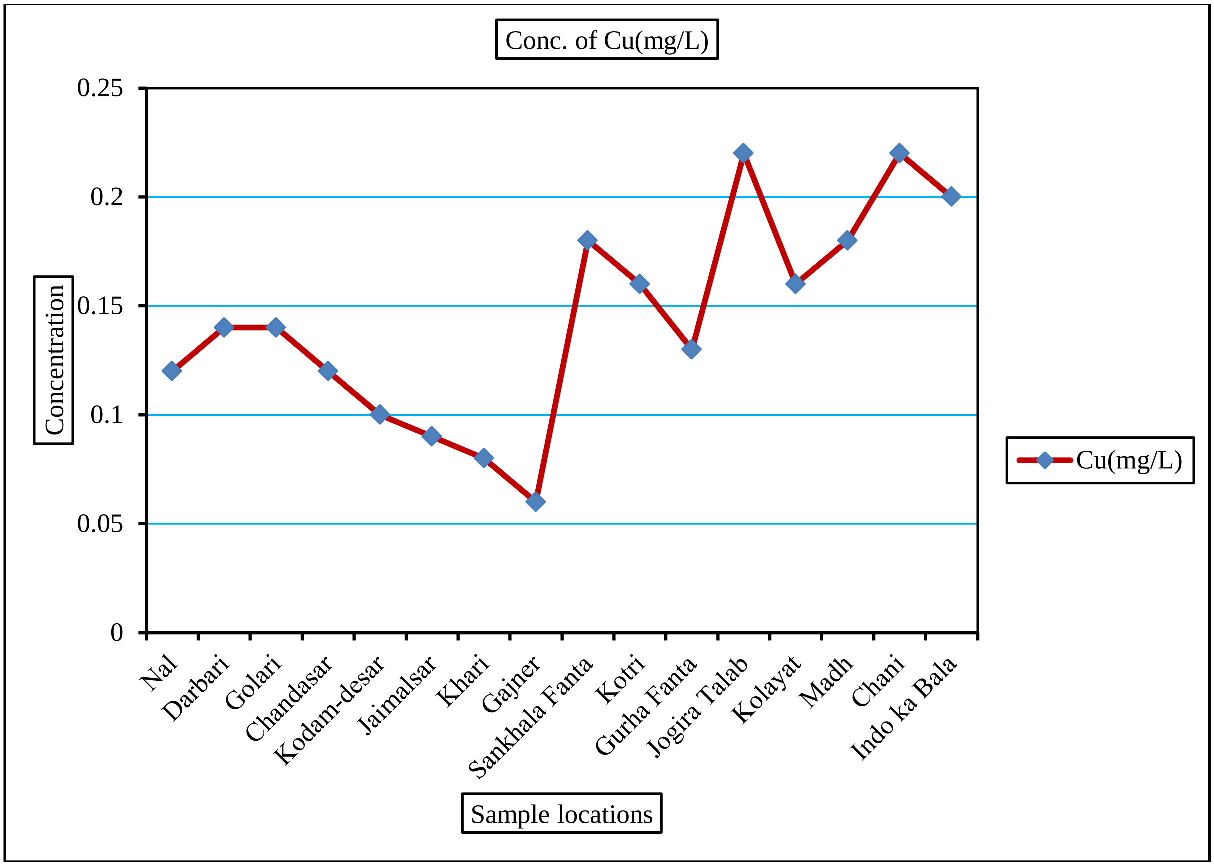


**Figure-6:** Showing concentration of Cu in surface water bodies samples of study area.

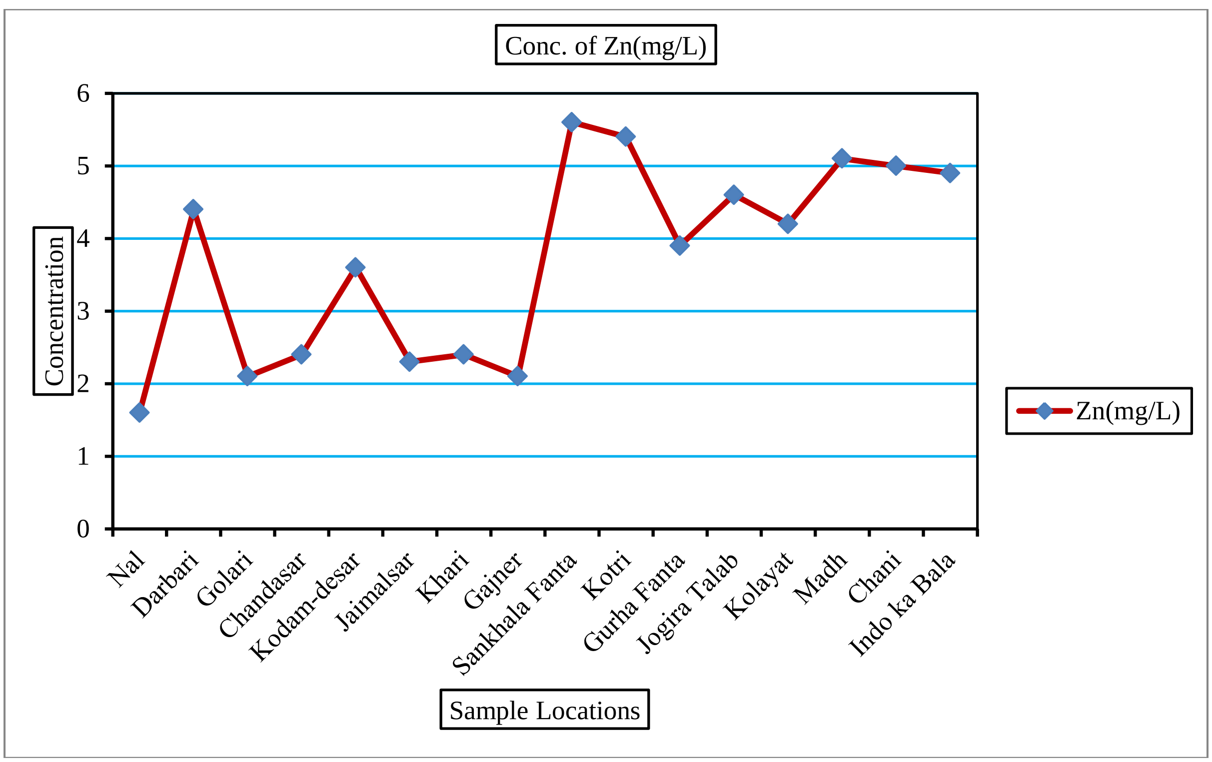


**Figure-7:** Showing concentration of Zn in surface water bodies samples of study area.

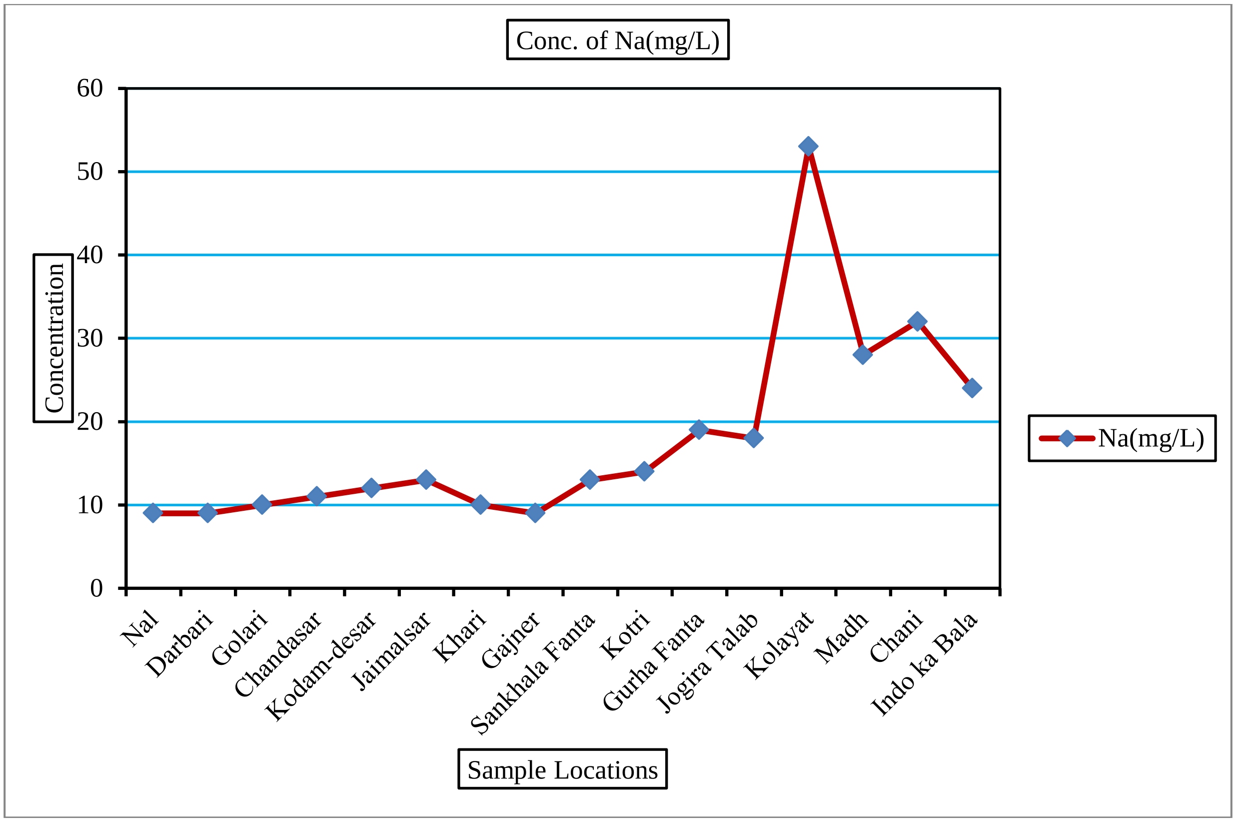


**Figure-8:** Showing Na concentration in surface water bodies samples of study area.

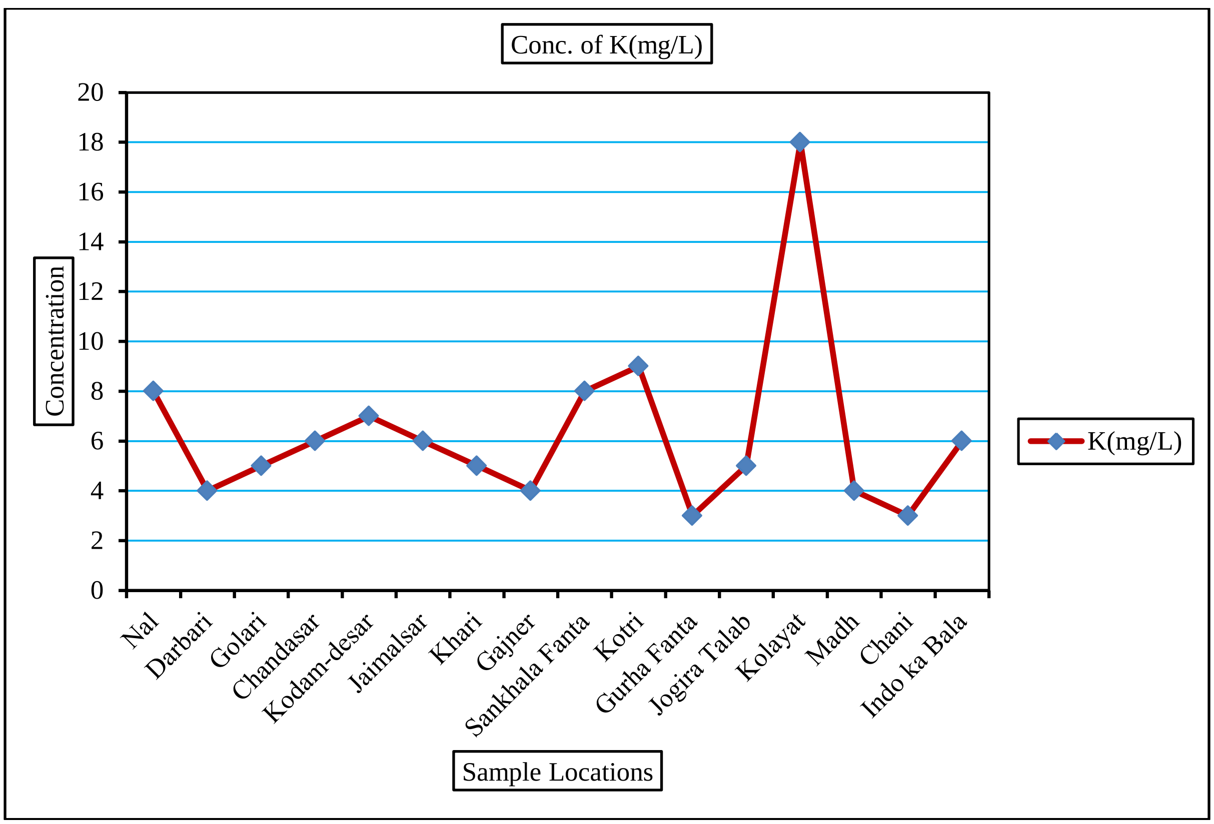


**Figure-9:** Showing K concentration in surface water bodies samples of study area.

**Table-1:** Concentration of heavy metal in water samples of surface water bodies of mining and non-mining vicinity of study area.

| Location | Area Type | Fe (mg/l) | Mn (mg/l) | Cu (mg/l) | Zn (mg/l) | Na (mg/l) | K (mg/l) |
|---|---|---|---|---|---|---|---|
| Nal | Non-mining area samples | 0.06 | 0.06 | 0.12 | 1.6 | 9 | 8 |
| Darbari | | 0.04 | 0.04 | 0.14 | 4.4 | 9 | 4 |
| Golari | | 0.08 | 0.006 | 0.14 | 2.1 | 10 | 5 |
| Chandasar | | 0.02 | 0.074 | 0.12 | 2.4 | 11 | 6 |
| Kodam-desar | | 0.04 | 0.045 | 0.1 | 3.6 | 12 | 7 |
| Jaimalsar | | 0.04 | 0.035 | 0.09 | 2.3 | 13 | 6 |
| Khari | | 0.05 | 0.026 | 0.08 | 2.4 | 10 | 5 |
| Gajner | | 0.02 | 0.028 | 0.06 | 2.1 | 9 | 4 |
| Sankhala Fanta | Mining area samples | 0.12 | 0.078 | 0.18 | 5.6 | 13 | 8 |
| Kotri | | 0.22 | 0.082 | 0.16 | 5.4 | 14 | 9 |
| Gurha Fanta | | 0.18 | 0.01 | 0.13 | 3.9 | 19 | 3 |
| JogiraTalab | | 0.16 | 0.015 | 0.22 | 4.6 | 18 | 5 |
| Kolayat | | 0.14 | 0.056 | 0.16 | 4.2 | 53 | 18 |
| Madh | | 0.12 | 0.019 | 0.18 | 5.1 | 28 | 4 |
| Chani | | 0.16 | 0.012 | 0.22 | 5 | 32 | 3 |
| Indo kaBala | | 0.14 | 0.015 | 0.2 | 4.9 | 24 | 6 |

## Conclusion

Evaluation of heavy metals in bodies of water of mined out areas and non-mined out areas of study area reveals that the concentration of the Fe, Mn, Zn, Cu and Na and K are below the recommended limit of drinking purposes. The local people in study area use this water for drinking and household purposes. The analyzed results of samples of water bodies of mined affected and non-mined areas reveals that the mining affected areas have higher concentration of heavy metals than the non-mining affected areas. Even though, the results show the controlled situation of heavy metal contaminations in study area. Hence it is recommended that the mining and related activities which are continues in study area should be properly planned and not to disturb the natural drainage system of local talav, nadi, johad etc. so that water of surface bodies can be maintain its quality for purposed of local peoples and as well cattle. It is essential to preserve and protect to natural resources of water for better future of coming generations and for humanity.

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