Evaluation of Water Quality of Malini River in Kotdwar Uttarakhand

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Abstract
Malini river originates from the Kotdwar and merges with Ganga at Ravalli Ghat in Dist. Bijnor. It is an important river of city Najibabad, Uttar Pradesh because it is the main source of irrigation for agriculture in the most areas of city Najibabad. At some places cloth washing and vegetable washing is the main activity on the Malini river bank. Four sampling sites were established for the collection of water samples during July, 2019 to June, 2020 but in the present study average of all the values of all the four sites was given. Monitoring of water of river Malini includes physio-chemical parameters like temperature, turbidity, total solids, total suspended solids, total dissolved solids, pH, total hardness, calcium hardness, magnesium hardness, total alkalinity, chloride, acidity., dissolved oxygen, biochemical oxygen demand and chemical oxygen demand. TDS, total hardness, calcium hardness and magnesium hardness was found beyond the limit at all the four sampling sites and rest all the parameters were found within the limit. The average values of TDS, BOD, COD and TH were observed 635.1 mg/l±55.31, 12.1±0.54, 35.2±1.01, 341.0±1.84. Further water quality of river Malini has been assessed using water quality index and the quality of river Malini was observed to be bad at all site which may be attributed to untreated and/or partially treated waste inputs of municipal and industrial effluents joining the river.

Keywords: Soil Quality, Microbial Diversity, Turbidity Malini River, Non-perennial, Ravalli Ghat, WQI

Introduction

River form the lifeline human society and play an important role in the development of nation and sustenance of life which are being polluted due to rapid industrialization, urbanization and other development activities these are vital fresh water system of strategic importance across the world providing main water resources of domestic, industrial agricultural. Most of the agriculture area in India receives its water from surface sources like river reservoir dam etc. River may be perennial as well as non-perennial as well as non-perennial river water flow for all these as on because such river is now fed. The non-perennial rivers get dried in summer either partially or completely and in monsoon they are flooded with water generally the quality of water analysis from perennial river varies throughout the year it normally decreases in summer when demand for water is at its maximum. The Malini river under study is also non perennial river. Insufficient capacity of wastewater treatment and increasing sewage generation on pore big question of disposal of wastewater. Industrial waste effects the ground water, these pollutants not only alter the quality of ground water but also pose serious problems (Karthikeyan et al., 2010). Microbial activity in the ecosystem. The WQI was first developed by Horton in the early 1970s. The basic aim of WQI is to give a single value to the water quality of a source on the basis of one or the other system which translates the list of constituents and their concentrations present in a sample in to a single value (Abbasi and Abbasi, 2012). The index result represents the level of water quality in a given water basin, such as lake, river or stream.

After Horton a number of workers all over the world developed WQI based on rating of different water quality parameters. For the evaluation of water quality, WQI was applied to the river water (Singh, 1992; Naik and Purohit, 2001; Kumar and Dua, 2009; Kumar et al., 2009, Sharma et al., 2009; Singkran, et al., 2010; Gupta, et al., 2012). In the present paper, characteristics of different point sources contributing Malini river are discussed, water quality of river Malini using water quality index. The river under study was also heavily polluted due to sewage and industrial discharge (Bhutian and Ahammad, 2018) Controlling water pollution is urgent for ecological sustainability of water resource as well as for underlying economic reasons and human health the availability of good quality waste water is an indispensable features for preventing diseases and improving quality of life. It is necessary to know information about different physiochemical parameters before it is used for different purposes (Kolhe and Shinde) the term water quality 2014 was developed to given Indication of how suitable the water is for human consumption (Vaux, 2001) and is widely used in multiple scientific publications related to the necessities of sustainable water management, (Parparov et al., 2006).

Materials and Methods

Study Area

The present study area was performed on Malini river which is situated in Najibabad, Dist. Bijnor, Uttar Pradesh. Najibabad is located at 29.63N,78.33E. It has an elevation of 295 meter (1,014 feet) Malini river is the principle source of water for agriculture and other activities the river is formed by joining of many mountain spring in Garhwal region. It is non-perennial river, get partially dried in summer and it is flooded with water in monsoon. Thus the quantity of water available from river varies throughout the year. It normally decreases in summer when the demand for water is on peak. Malini river covers about 140-150 km with a catchment area of about 400 km^2 through three districts named Pauri Garhwal, Kotdwar and Bijnor. Malini river merges in the Ganga river at the Ravalli Ghat in the Bijnor city. The main activities responsible for Malini river water pollution are run off from agricultural fields, domestic waste form the city and villages situated on the bank of river and effluent from Kishan Sahkari Sugar mill. All the sampling sites were shown in Figure 1.

Sr. No.	Sampling Sites	Co-ordinates
1	Malin river near Shahpur village (Figure 2)	29.62N, 78.33E
2	Malin river near Basanti Mata palace (Figure 3)	29.61N, 78.33E
3	Malin river near Alipura village (Figure 4)	29.61N, 78.31E
4	Malin river near Kalheri village (Figure 5)	29.61N, 78.29E

Water Sampling

Results and Discussion

Source of Pollution

The industries in SIDCUL (Kotdwar) region were started in 2013. Nearly 35 industries are established and prosper at the Sigaddi growth center. and now they are generating about millions of liters of effluents per day. Approx. 70-80% of effluents are discharge into the soil surface and underwater bodies. The effluents are not only rich in waste but also contain toxic materials which is dangerous and hazardous to humans. The major industries draining effluents into soil surface and ground water bodies. Near SIDCUL Kotdwar the iron industries also effects soil surface and soil microbes with their effluents.

Effect of Industrialization on Water Quality

For assessing the quality of water for drinking purpose in Kotdwar and its adjoining region various water parameters were tested and compared with values of ISI. The value of pH in control and industrial site of pH varied from control to industrial from 7.5 to 6.0 pH value in industrial area and non-industrial area are varies was within desirable limit of 6.5-8.5. The value of pH was in accordance with the alkalinity value, which decreased from control site to industrial site. Kotdwar it was 200 mg/l in control site and 150 mg/l in industrial site. The desirable limit of TDS is 300 mg/l but in both the area industrial and non-industrial the TDS value was greater than desirable in both control and industrial site. But from control to industrial there was increase of TDS value from 692 mg/L to 750 mg/l in Kotdwar affects the quality of water. The value of Turbidity was 0 NTU in both control and industrial which is desirable. The total hardness which is mainly caused due to calcium and magnesium salts were within the desirable limit of less than 300 ppm. The desirable limit of chloride according to ISI is 250 ppm and in both area the value of chloride decreased from control to industrial site.

Physio Chemical Parameters

The change in soil pH and organic carbon, total nitrogen, total phosphorus and organic matter (percent dry weight basis) contents were determined following standard procedures. The physic-chemical characters like

Turbidity and conductivity, pH, temperature, chlorides, sulfate, nitrates, phosphate and total hardness have increased in the water of the impacted sample.

Water Quality Parameters

The results of various physio-chemical parameters of river Malini analysed during the study period (Average results of all the four sites from July 2015 to June 2016) are tabulated in Table 2 and 3 and Graph 1 and 2, while their WQI values are given in Table 4.

Turbidity (NTU)

It is an important factor that controls the energy relationship at different tropic levels. It is essentially a function of reflection of light from the surface and is influenced by the absorption characteristics of both water and of its dissolved and particulate matter. During the study period the monthly values of turbidity was ranged from 22.7 NTU to 83.3 NTU.The minimum monthly average value of turbidity were found 27.2±3.53 NTU in the month of June and maximum monthly average value of turbidity were found 70.1±16.32 NTU in the month of August (Table 2 and Graph 1). Turbidity values are generally found higher in Monsoon period due to heavy rainfall in mountain areas of Kotdwar region, the origin Point of Malini river. The annual values of turbidity were ranged from 35.7 NTU to 48.9 NTU and annual average was observed 43.9±15.56. A more or less same trend was observed by Khanna et al., 2010; Bhutiani et al., 2015.

Total Solids (mg/l)

The Total Solids (TS) represent the total salt's and dirt's remain after a particular amount of water sample evaporated. Ecological imbalance in the aquatic ecosystem was caused by technical abrasive action of total solids. During the study period the monthly values of TS was ranged from 808.0 mg/l to 1094.7 mg/l. The minimum monthly average value of TS were found 864.0±58.07 mg/l in the month of May and maximum monthly average value of TS were found 1074.1±22.31 mg/l in the month of August (Table 2 and Graph 1). TS values are generally found higher in Monsoon period due to heavy rainfall in mountainous areas of Kotdwar region, the origin Point of Malini river. In rainy season when rainfall occurs the river flows with a high velocity and caused soil erosion in nearby areas which increase the total solids in river water. The annual average values of TS were ranged from 939.3 mg/l to 991.4 mg/l and annual average values were observed 963.1±78.64. A more or less same trend was observed by Bhutiani and Khanna, 2005.

Total Dissolved Solid (mg/l)

Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulphates) and some small amounts of organic matter that are dissolved in water. It signifies the inorganic pollution load of water system. During the study period the monthly values of TDS was ranged from 512.0 mg/l to 746.3 mg/l. The minimum monthly average value of total dissolved solid were found 561.7±52.32 mg/l in the month of May and maximum monthly average value were observed 714.8±22.12 mg/l in the month of August (Table 2 and Graph 1). The annual average values of TDS were ranged from 623.7 mg/l to 642.1 mg/l, and annual average were observed 635.1±55.31 mg/l. A more or less same trend was observed by Khanna et al., 2014 and Bhutiani et al., 2017.

Total Suspended Solids (mg/l)

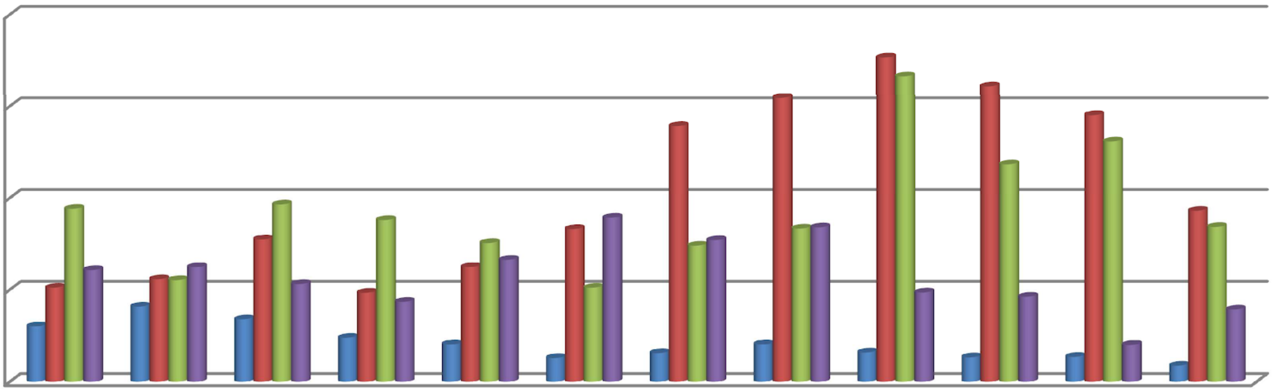
Total Suspended Solids (TSS) was previously called non-filterable residue (NFR), but was changed to TSS because of ambiguity in other scientific disciplines. During the study period the monthly values of TSS was ranged from 271.0 mg/l to 391.7 mg/l. The minimum monthly average value of total suspended solid were found 297.0±15.68 mg/l in the month of June and maximum monthly average value were observed 359.3±24.91 mg/l (in the month of August (Table 2 and Graph 1). The annual average values of TSS were ranged from 305.4 mg/l to 350.4 mg/l and annual average were observed 327.9±24.0 mg/l. A more or less same trend was observed by Khanna et al., 2014; Bhutiani et al., 2018.

pH

The increase in pH associated with increasing use of alkaline detergents in residual areas and alkaline material from waste water in industrial process. During the study period the monthly values of pH was ranged from 6.2 to 7.6. The minimum monthly average value of pH was found 6.9±0.38 in the month of June and maximum monthly average value was observed 7.3±0.17 in the month of July (Table 3 and Graph 2). The decrease in the pH values in summer season was found due to sugar mill effluent mixing. The annual average values of pH were ranged from 6.7 to 7.4 and annual average were observed 7.1±0.10. A more or less same trend was observed by Sharma and Kansal, 2011; Yadav and Mishra, 2014; Shah and Joshi, 2017 and Bhutiani and Khanna, 2007.

Table 2: Monthly Average Value of Different Physical Parameter at Different Sampling Sites

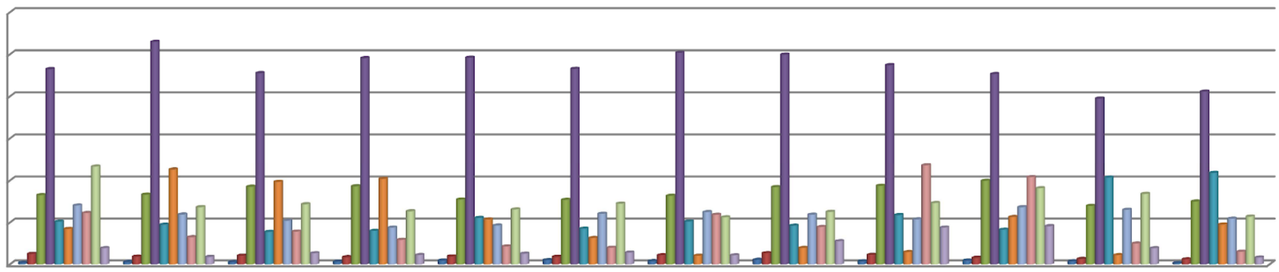
Date / Parameter	Turbidity (NTU)	Total Solids (TS) (mg/l)	Total Dissolved Solids (TDS) (mg/l)	Total Suspended Solid (TSS) (mg/l)
July-15	64.5±11.99 (47.7-76)*	1038.3±20.44 (1012.7-1062.7)*	679.3±37.63 (646.0-729.7)*	359.0±24.30 (333.0-391.7)*
August-15	70.1±16.32 (47.3-83.3)*	1074.1±22.31 (1042.7-1094.7)*	714.8±22.12 (696.7-746.3)*	359.3±24.91 (329.3-380.3)*
September-15	61.5±13.55 (45.7-75.7)*	1047.8±30.98 (1011.7-1078.0)*	693.9±38.57 (641.0-733.0)*	354.4±21.25 (335.7-374.7)*
October-15	56.2±9.52 (43.3-66.0)*	1020±19.34 (995.7-1043.0)*	674.8±35.20 (636.7-719.3)*	345.3±17.37 (323.7-359.7)*
November-15	47.7±8.12 (40.3-59.3)*	1019.5±24.95 (990.0-1040.7)*	677.0±30.20 (637.0-700.7)*	342.5±26.50 (307.7-370.3)*
December-15	42.1±5.20 (39.3-47.7)*	997.7±33.23 (971.7-1044.7)*	658.5±20.44 (629.3-675.3)*	338.5±35.68 (299.0-384.7)*
January-16	34.9±6.28 (26.7-37.0)*	947.9±55.66 (875.0-1010.0)*	632.9±29.59 (604.0-670.3)*	315.0±30.78 (271.0-339.7)*
February-16	33.2±8.12 (27.7-45)*	923.7±61.89 (847.7-996.0)*	610.6±33.33 (566.7-637.3)*	313.0±33.58 (281.0-360.3)*
March-16	30.4±6.41 (25.3-39.7)*	889.2±70.69 (817.3-962.7)*	588.5±66.57 (523.3-658.7)*	304.8±19.39 (291.3-333.3)*
April-16	30.7±5.36 (24.7-36.0)*	869.7±64.40 (809.0-935.0)*	565.4±47.33 (516.7-607.3)*	304.3±18.47 (287.0-327.7)*
May-16	28.4±5.45 (22.7-35.3)*	864.0±58.07 (808.0-918.7)*	561.7±52.32 (512.0-609.0)*	302.3±7.99 (296.0-314.0)*
June-16	27.2±3.53 (24.3-32.3)*	865.9±37.23 (835.0-913.7)*	564.4±33.67 (522.3-594.0)*	297.0±15.68 (285.3-319.7)*
Average ± SD	43.9±15.56 (35.7-48.9)*	963.1±78.64 (939.3-991.4)*	635.1±55.31 (623.7-642.1)*	327.9±24.07 (305.4-350.4)*



Graph 1: Showing Annual Variations in Different Physical Parameters of Malini River

Table 3: Monthly Average Value of Different Chemical Parameters at Different Sampling Sites (*Range)

Date / Parameter	pH	DO	BOD	COD	Alkalinity	Chloride	Total Hardness	Calcium Hardness	Magnesium Hardness
Jul. 15	7.3±0.17 (7.0-7.4)*	7.6±1.25 (6.1-9.1)*	12.4±8.25 (4.8-22.3)*	37.1±23.24 (14.9-63.4)*	121.2±5.10 (116.5-127.0)*	27.3±7.02 (21.7-37.0)*	342.2±6.14 (336.9-348.4)*	116.8±11.66 (109.6-113.6)*	55.0±1.93 (52.3-56.9)*
Aug. 15	7.2±0.27 (6.8-7.4)*	7.3±0.91 (6.2-8.3)*	12.4±8.31 (4.9-22.7)*	34.8±26.48 (5.3-63.4)*	119.7±4.74 (112.6-122.6)*	27.7±5.95 (22.3-35.4)*	343.4±3.24 (340.5-347.9)*	116.7±6.83 (108.7-125.1)*	55.3±0.88 (54.4-56.5)*
Sep. 15	7.1±0.26 (6.7-7.3)*	7.2±1.04 (5.9-8.2)*	12.8±9.26 (4.3-24.5)*	35.9±22.76 (13.1-60.8)*	120.2±3.87 (115.2-124.6)*	26.9±5.22 (22.5-33.4)*	341.4±3.93 (339.2-347.1)*	116.0±7.17 (108.9-124.3)*	55.0±1.34 (53.4-56.2)*
Oct. 15	7.1±0.32 (6.7-7.4)*	7.2±0.85 (6.1-7.9)*	12.5±9.31 (4.1-24.1)*	35.8±24.54 (13.0-62.7)*	120.6±4.00 (115.3-124.8)*	27.0±4.40 (23.2-32.4)*	340.2±2.93 (336.3-343.4)*	116.4±6.34 (110.5-122.6)*	54.7±1.11 (53.6-56.0)*
Nov. 15	7.0±0.46 (6.5-7.6)*	7.4±0.95 (6.4-8.4)*	11.5±7.73 (3.8-19.9)*	36.0±24.59 (11.0-62.6)*	118.9±5.55 (110.9-123.6)*	26.5±4.64 (22.3-32.2)*	341.3±2.14 (339.2-344.3)*	116.0±6.56 (108.8-123.9)*	55.0±1.27 (53.8-56.2)*
Dec. 15	7.0±0.52 (6.4-7.6)*	7.6±0.89 (6.7-8.5)*	12.0±7.69 (3.9-20.7)*	35.9±23.27 (11.6-61.6)*	120.5±4.27 (114.9-125.0)*	27.6±6.04 (22.6-35.9)*	341.5±1.99 (340.5-344.5)*	116.8±7.25 (109.3-125.6)*	54.8±1.41 (53.4-56.4)*
Jan. 16	6.9±0.38 (6.4-7.3)*	8.0±1.09 (6.9-9.4)*	11.7±8.18 (3.8-21.0)*	35.2±25.19 (10.4-62.3)*	119.9±5.13 (112.6-124.5)*	28.6±6.23 (24.3-37.7)*	344.1±5.92 (339.3-351.7)*	117.3±5.63 (110.6-123.8)*	55.8±1.08 (54.2-56.7)*
Feb. 16	7.0±0.54 (6.2-7.4)*	7.9±1.34 (6.7-9.7)*	12.1±9.21 (3.7-23.7)*	34.9±24.95 (11.4-64.1)*	119.3±4.62 (114.6-123.8)*	28.9±5.93 (23.9-37.0)*	338.7±4.46 (332.2-342.3)*	115.3±6.27 (111.8-124.7)*	54.7±2.77 (50.9-56.5)*
Mar. 16	7.1±0.36 (6.8-7.6)*	7.8±1.13 (7.0-9.4)*	12.4±9.37 (4.0-24.7)*	34.5±23.71 (11.6-63.6)*	122.1±5.88 (113.4-126.2)*	28.4±5.38 (24.4-36.0)*	337.8±11.81 (320.8-347.3)*	119.3±7.32 (112.1-129.3)*	53.3±4.40 (46.7-55.6)*
Apr. 16	7.1±0.45 (6.5-7.6)*	7.4±0.78 (6.8-8.5)*	13.0±9.97 (4.1-26.0)*	35.5±22.65 (13.8-61.2)*	121.0±4.15 (117.3-125.6)*	28.9±6.82 (22.9-38.7)*	339.2±10.39 (324.1-346.9)*	114.5±9.08 (106.2-127.0)*	54.8±4.57 (48.1-58.3)*
May 16	7.2±0.36 (6.7-7.5)*	7.5±0.64 (6.9-8.4)*	11.2±9.98 (4.8-19.6)*	33.2±19.75 (13.8-56.1)*	121.8±10.35 (99.1-136.7)*	28.3±6.52 (23.6-37.9)*	341.0±2.49 (338.4-343.9)*	114.0±8.41 (112.4-125.7)*	55.4±1.93 (52.8-57.1)*
Jun. 16	7.0±0.15 (6.9-7.2)*	7.3±0.61 (6.6-8.2)*	11.6±7.50 (4.3-20.6)*	34.3±20.57 (14.6-59.2)*	121.6±10.90 (111.8-136.3)*	28.7±5.46 (24.0-36.5)*	341.6±1.51 (339.5-343.0)*	115.8±5.71 (110.9-123.1)*	55.4±0.81 (54.8-56.3)*
Avg. ± SD	7.1±0.10 (6.7-7.4)*	7.5±0.27 (6.3-8.7)*	12.1±0.54 (4.2-22.5)*	35.2±1.01 (12.0-61.8)*	120.6±1.01 (114.0-126.4)*	27.9±0.85 (23.2-35.8)*	341.0±1.84 (339.2-343.7)*	116.2±1.37 (111.0-125.8)*	54.9±0.61 (52.5-56.2)*



Graph 2: Showing Annual Variations in Different Chemical Parameters of Malini River

Dissolved Oxygen (mg/l)

The amount of DO present in surface waters depends on water temperature, turbulence, salinity, and altitude natural waters in equilibrium with the atmosphere will contain DO concentrations ranging from about5 to 14.5 mg O2 per litre. The DO concentration present in water reflects atmospheric dissolution, as well as autotrophic and heterotrophic processes that, respectively, produce and consume oxygen. DO is the factor that determines whether biological changes are brought by aerobic or anaerobic organisms. Thus, dissolved–oxygen measurement is vital for maintaining aerobic treatment processes intended to purify domestic and industrial waste waters. A rapid fall in the DO indicates a high organic pollution in the river (Shah and Joshi, 2017)**.** During the study period the monthly values of Dissolved Oxygen was ranged from 5.9 mg/l to 9.4 mg/l. The minimum monthly average value of Dissolved Oxygen were found 7.2±1.04 mg/l in the month of September and maximum monthly average value were observed 8.0±1.09 mg/l in the month of June (Table 3 and Graph 2). The annual average values of Dissolved Oxygen were ranged from 6.3 mg/l to 8.7 mg/l and annual average were observed 7.5±0.27 mg/l. A more or less same trend was observed by Kumar et al., 2012; Arya and Gupta 2013; Bhutiani et al., 2018.

Biological Oxygen Demand (mg/l)

Biological oxygen Demand is a measure of oxygen in the water that is required by the aerobic organisms to decompose the organic matter. During the study period the monthly values of biological oxygen demand (BOD**)** was ranged from 3.7 mg/l to 26.0 mg/l. The minimum monthly average value of biological oxygen demand (BOD) were found 11.2±9.98 mg/l in the month of May and maximum monthly average value were observed 13.0±9.97 mg/l in the month of April (Table 3 and Graph 2). The annual average values of biological oxygen demand (BOD) were ranged from 4.2 mg/l to 22.5 mg/l and annual average were observed 12.1±0.54 mg/l. A more or less same trend was observed by Kumar et al., 2012 and Sharma et al., 2014.

Chemical Oxygen Demand (mg/l)

COD is an oxygen demand to decompose the biodegradable as well as non-biodegradable organic waste. COD pointing to a deterioration of water quality likely caused by discharge of municipal waste water. Chemical oxygen demand (COD**)** was ranged from 5.3 mg/l to 63.6 mg/l. The minimum monthly average value of chemical oxygen demand (COD) were found 33.2±19.75 mg/l in the month of May and maximum monthly average value were observed 36.0±24.59 mg/l in the month of November (Table 3 and Graph 2). An increase in the COD values was found in winter because of sugar mill effluent mixing in the river water. The annual average values of chemical oxygen demand (COD) were ranged from 12.0 mg/l to 61.8 mg/l and annual average value were observed 35.2±1.01 mg/l. A more or less same trend was observed by Kumar et al., 2012 and Arya and Gupta 2013.

Alkalinity (mg/l)

Alkalinity is the name given to the quantitative capacity of water to neutralize an acid. During the study period the monthly values of Alkalinity was ranged from 99.1 mg/l to 136.7 mg/l. The minimum monthly average value of Alkalinity were found 118.9±5.55 mg/l in the month of November and maximum monthly average value were observed 122.1±5.88 mg/l in the month of March (Table 3 and Graph 2). The annual average values of Alkalinity were ranged from 114.0 mg/l to 126.4 mg/l and annual average value were observed 120.6±1.0 mg/l.

Chlorides (mg/l)

During the study period the monthly values of chlorides was ranged from 21.7 mg/l to 38.7 mg/l. The minimum monthly average value of chlorides were found 26.5±4.64 mg/l in the month of November and maximum monthly average value were observed 28.9±6.82 mg/l in the month of April (Table 3 and Graph 2). The annual average values of chlorides were ranged from 23.2 mg/l to 35.8 mg/l and annual average value were observed 27.9±0.85 mg/l. A more or less same trend was observed by Khanna et al., 2012, and approximately similar trend were observed by Bhutiani et al., 2017; Tyagi and Malik, 2018; and Arya and Gupta, 2013.

Total Hardness (mg/l)

Total hardness (TH) is a parameter of water quality used to describe the effect of dissolved mineral (Ca and Mg), determining solubility of water for domestic, industrial and drinking purpose attributed to presence of bicarbonates, sulphate, chloride and nitrates of Calcium and Magnesium. During the study period the monthly values of total hardness (TH) was ranged from 320.8 mg/l to 351.7 mg/l. The minimum monthly average value of total hardness (TH) were found 337.8±11.81 mg/l in the month of March and maximum monthly average value were observed 344.1±5.92 mg/l in the month of January (Table 3 and Graph 2). The annual average values of total hardness (TH) were ranged from 339.2 mg/l to 343.7 mg/l and annual average value were observed 341.0±1.84 mg/l. A more or less same trend was observed by Bhutiani et al., 2017.

Calcium Hardness (mg/l)

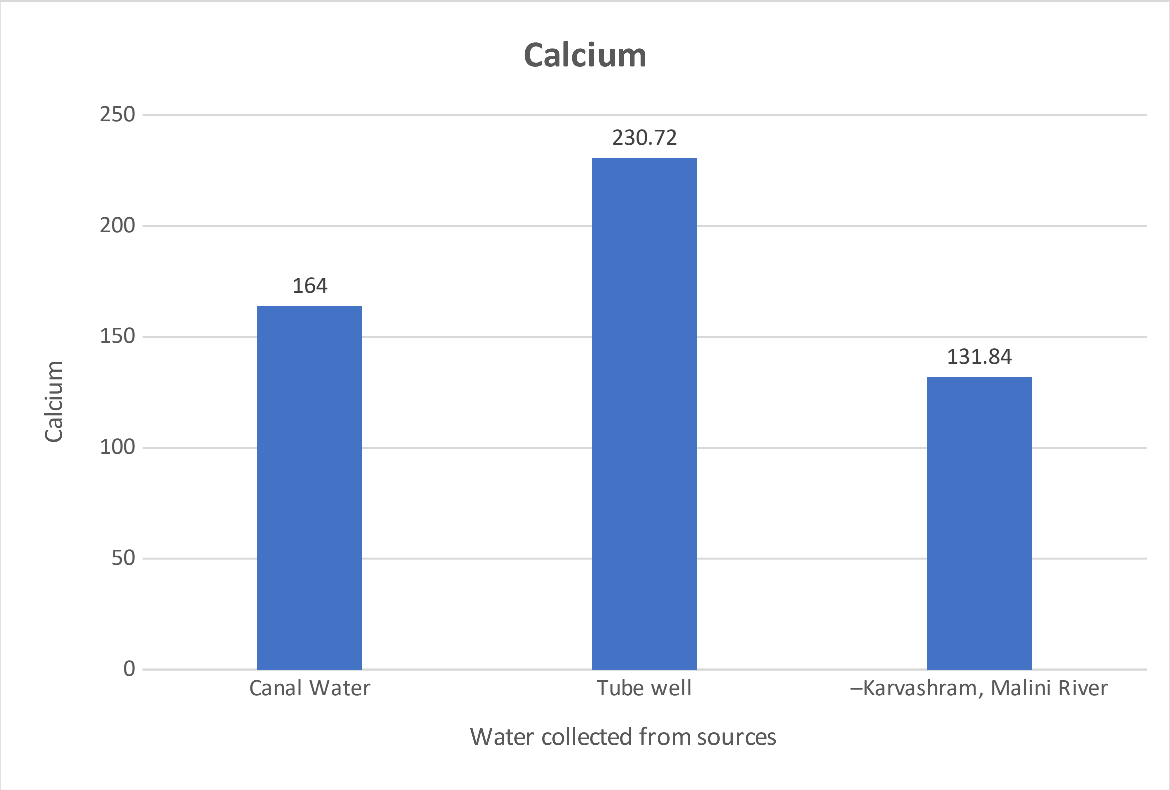
The occurrence of Calcium Hardness (CaH) in water is mainly due to the presence of lime stone, gypsum dolomite and gypsiferous material. During the study period the monthly values of calcium hardness (CaH) was ranged from 106.2 mg/l to 129.3 mg/l. The minimum monthly average value of calcium hardness (CaH) were found 114.0±8.41 mg/l in the month of May and maximum monthly average value were observed 119.3±7.32 mg/l in the month of March (Table 3 and Graph 2). The annual average values of calcium hardness (CaH) were ranged from 111.0 mg/l to 125.8 mg/l and annual average value were observed 116.2±1.37 mg/l. Approximately similar trend were observed by Arya and Gupta 2013; Bhutiani et al., 2016.

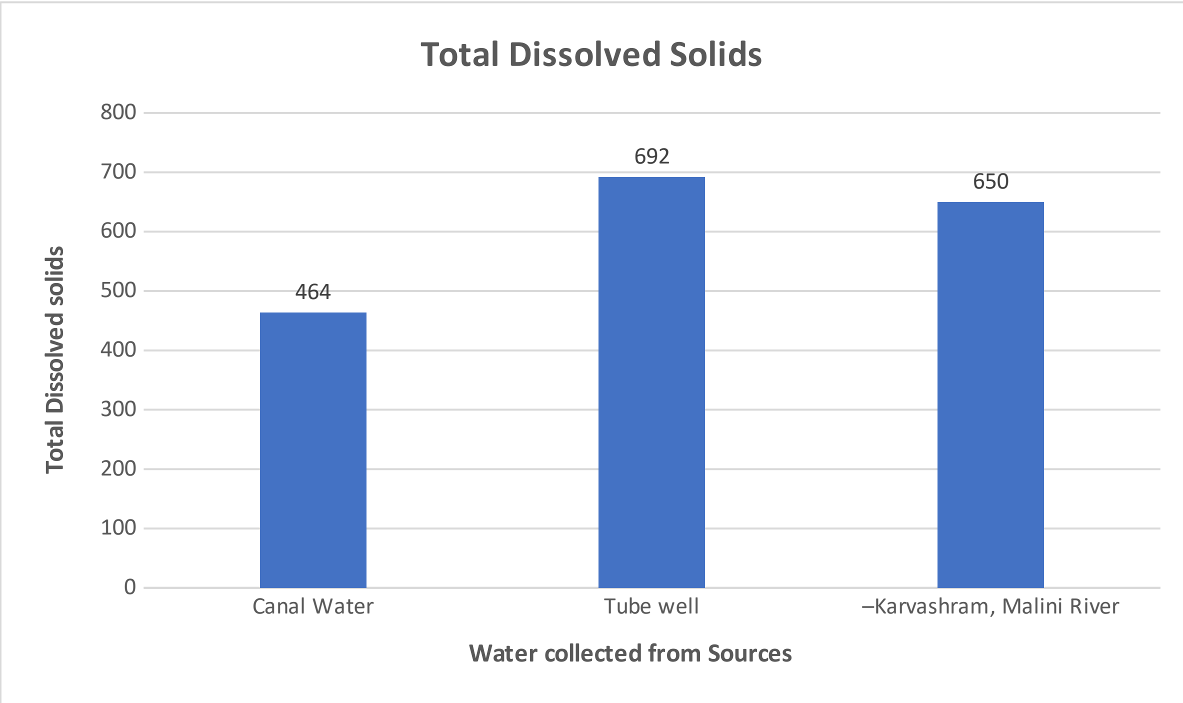
Magnesium Hardness (mg/l)

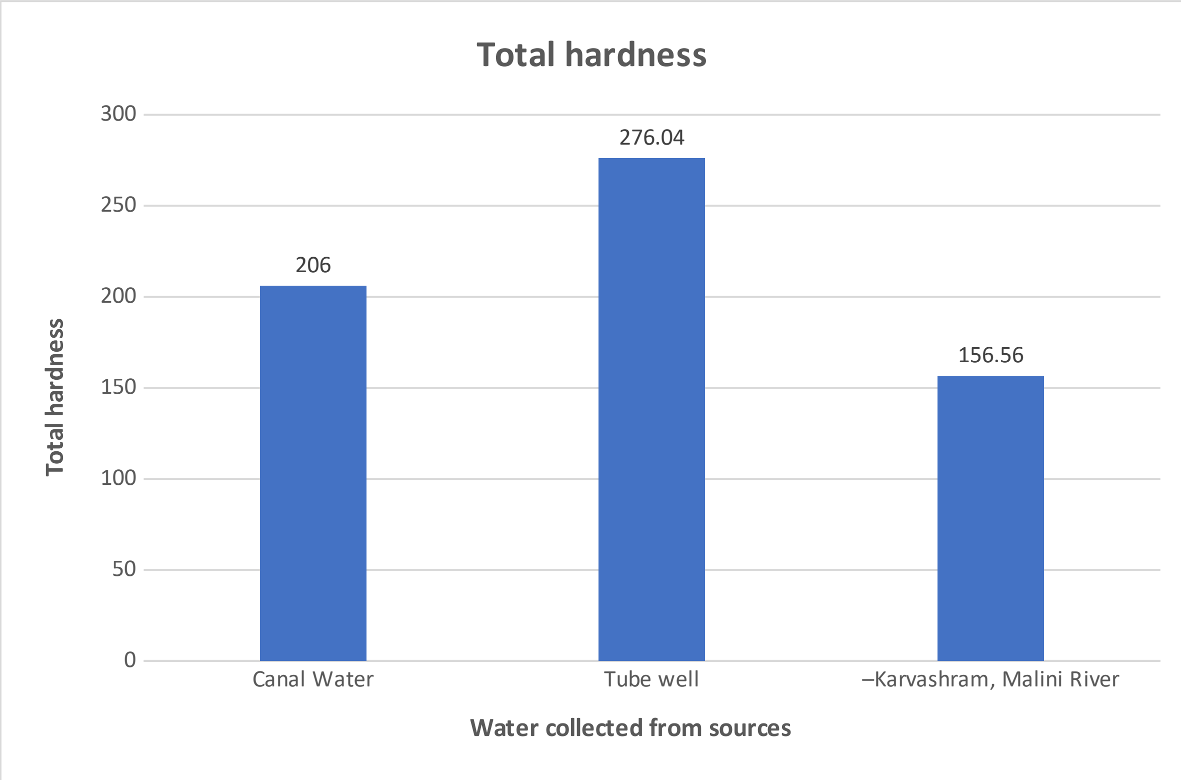
Magnesium ranked fourth after sodium in sea water. During the study period the monthly values of calcium hardness (CaH) was ranged from 106.2 mg/l to 129.3mg/l. The minimum monthly average value of calcium hardness (CaH) were found 114.0±8.41 mg/l in the month of May and maximum monthly average value were observed 119.3±7.32 mg/l in the month of March (Table 3 and Graph 2). The annual average values of calcium hardness (CaH) were ranged from 111.0 mg/l to 125.8 mg/l and annual average value were observed 116.2±1.37 mg/l. Approximately similar trend were observed by Arya and Gupta, 2013; Bhutiani et al., 2018.

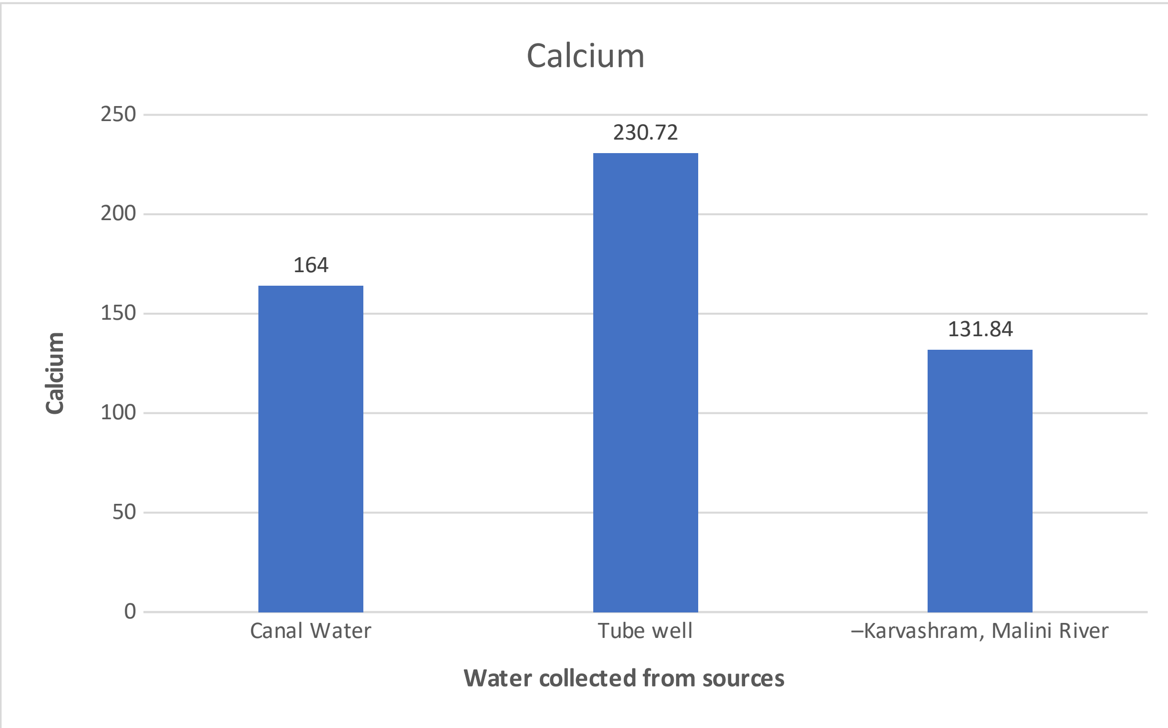
Water Quality Index

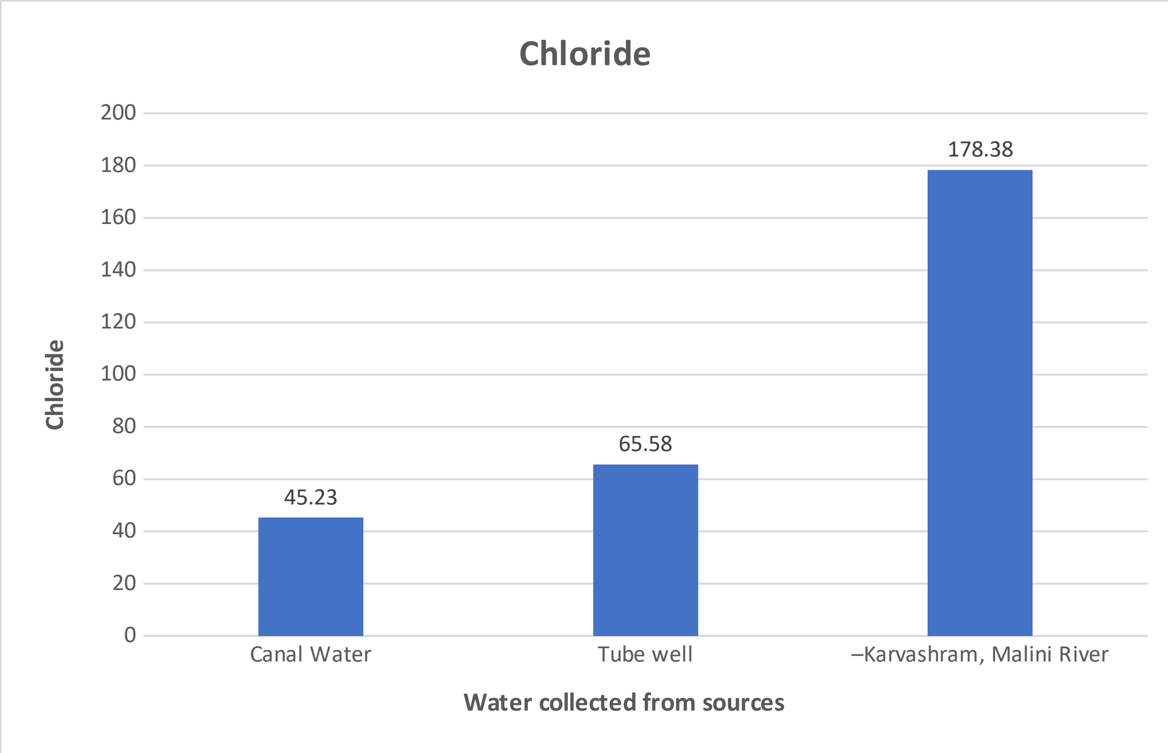
Water Quality Index allows for a general analysis of water quality on many levels that affect a stream's ability to host life and whether the overall quality of water bodies poses a potential threat to various uses of water. Water was calculated as 134.4260 which indicate (Table 1) that river water was seriously polluted during the study period. Similar water quality index (57-290) were observed by Chandra et al., 2017 for the water quality parameters of Vijayawada, Krishna district of Andhra Pradesh.

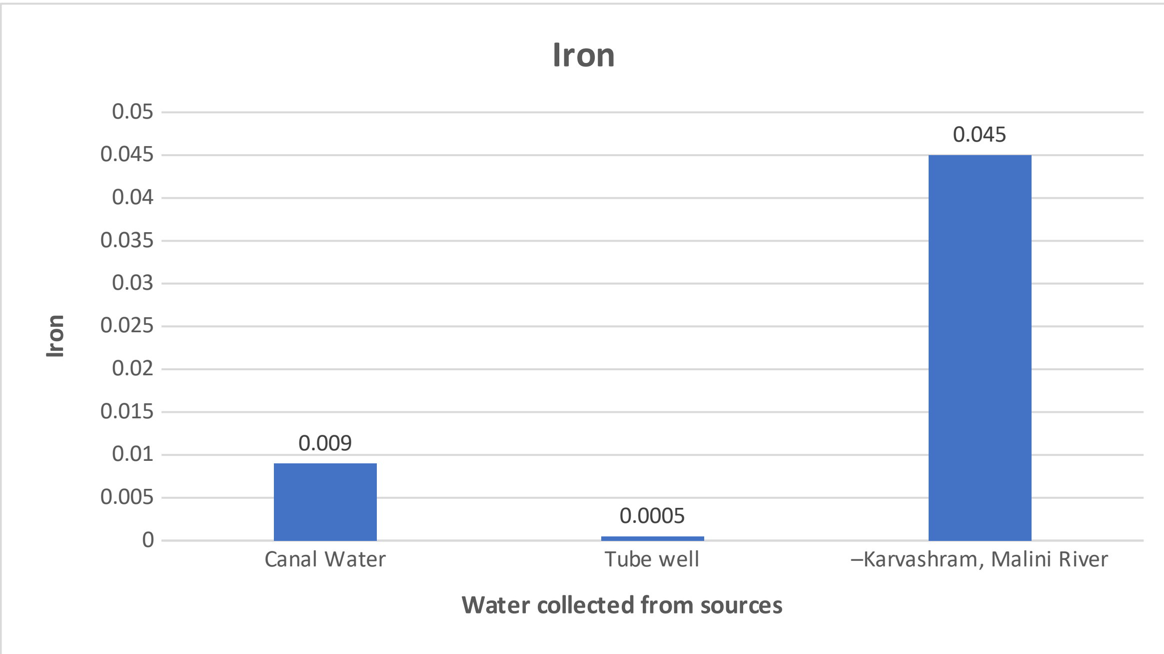


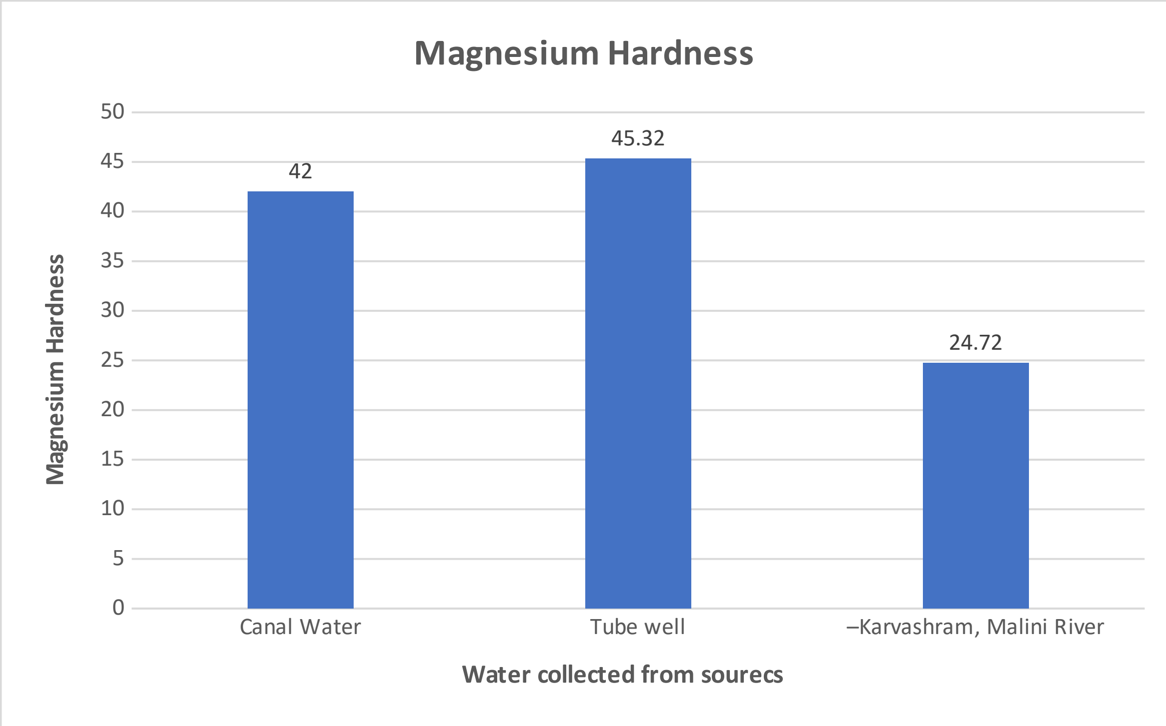


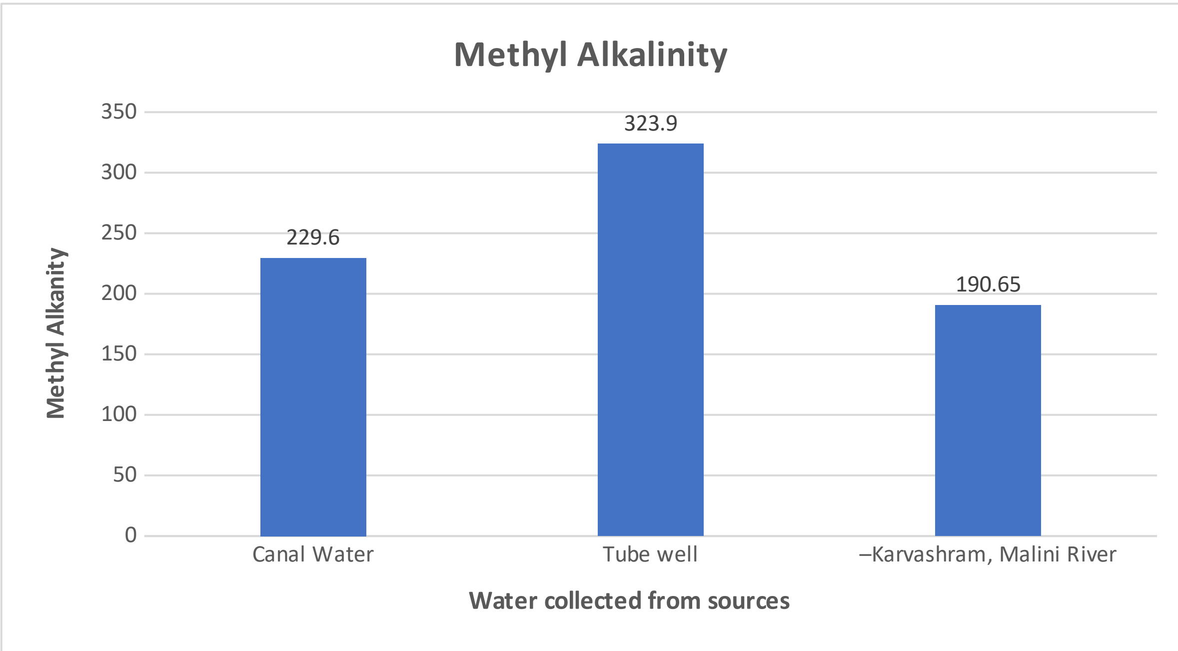

Total hardness
300
250
200
150
100
50
0
276.04
206
156.56
Total hardness
Canal Water
Tube well
–Karvashram, Malini River
Water collected from sources

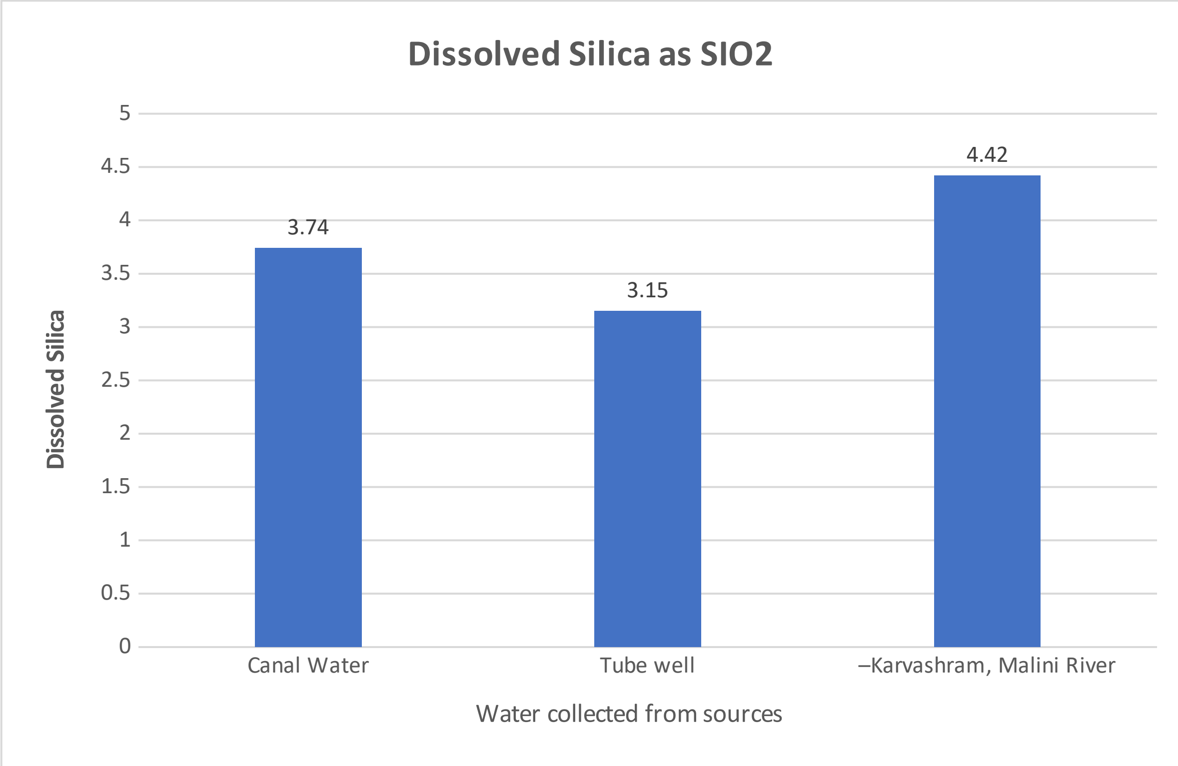

Calcium
250
200
150
100
50
0
230.72
164
131.84
Calcium
Canal Water
Tube well
–Karvashram, Malini River
Water collected from sources

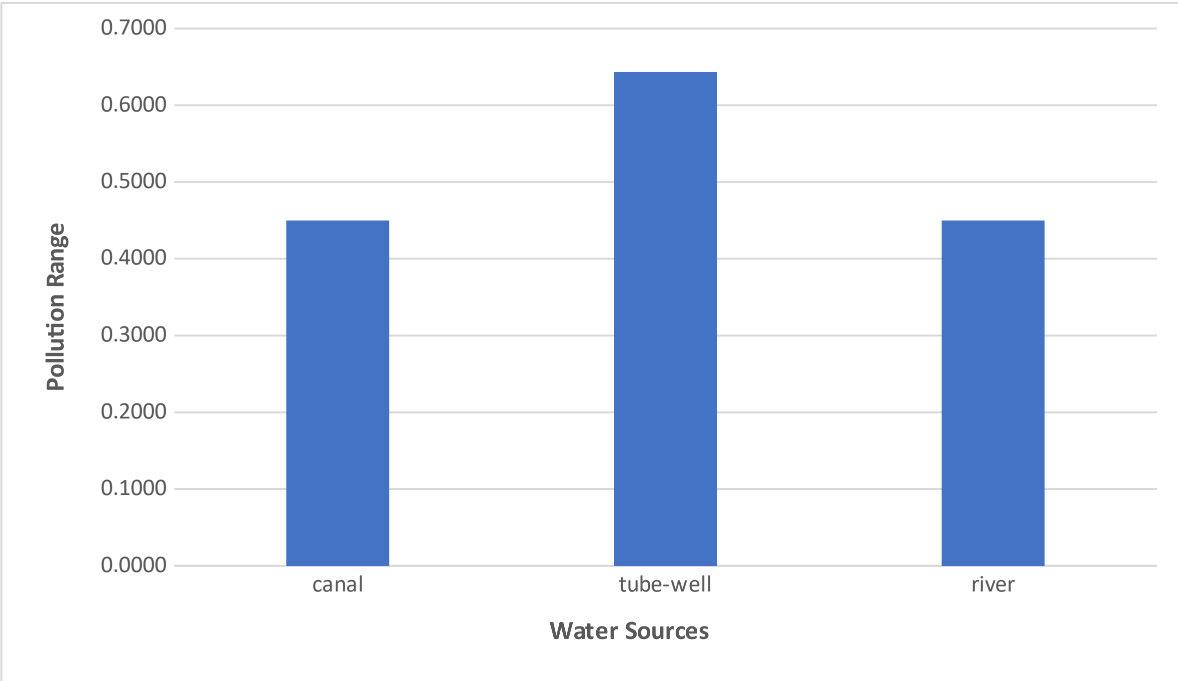

Chloride
200
180
160
140
120
100
80
60
40
20
0
Chloride
178.38
65.58
45.23
Canal Water
Tube well
–Karvashram, Malini River
Water collected from sources

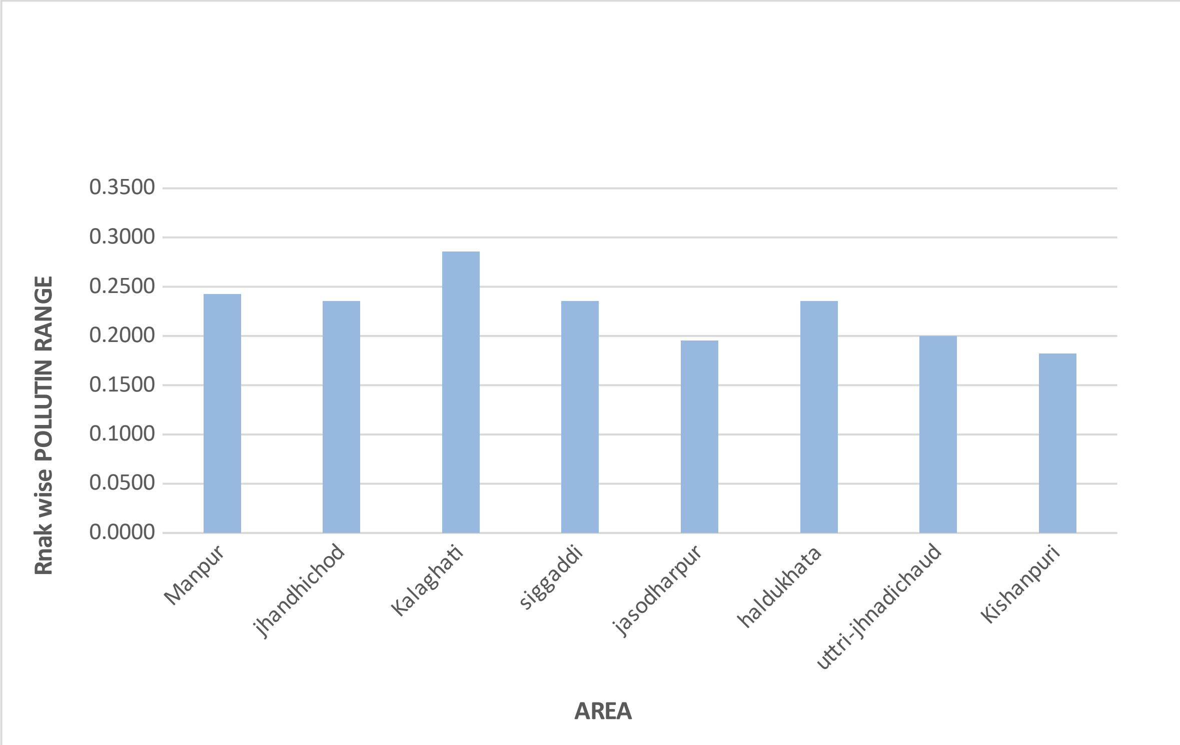

Iron
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Iron
0.045
0.009
0.0005
Canal Water
Tube well
–Karvashram, Malini River
Water collected from sources


Magnesium Hardness
Magnesium Hardness
50
45
40
35
30
25
20
15
10
5
0
42
45.32
24.72
Canal Water
Tube well
–Karvashram, Malini River
Water collected from sourecs


Methyl Alkalinity
Methyl Alkanity
350
300
250
200
150
100
50
0
229.6
323.9
190.65
Canal Water
Tube well
–Karvashram, Malini River
Water collected from sources


Dissolved Silica as SIO2
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Dissolved Silica
3.74
3.15
4.42
Canal Water
Tube well
–Karvashram, Malini River
Water collected from sources


0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
Pollution Range
canal
tube-well
river
Water Sources



Conclusion

The point sources contributing to river Malini have very high organic pollution deteriorating water quality of the river Malini. The river Malini is subjected to varying degree of pollution caused by numerous untreated and/or partially treated waste inputs of municipal and industrial effluents as assessed by water quality index also. Water quality index is an efficient tool to classify the water of the river for their various advantageous uses and give a rapid and precise idea about the pollution load in the river that may be worthwhile for policy makers. On the basis of the present investigation, it was found that the water Malini river is not fit for direct human consumption. Most of the parameters was found above the standard limit of WHO and BIS. The annual values of Some parameters such as chloride, COD and BOD was found under the limit but at some sites these parameters was found above the limits. On the basis WQI the river water was also found not only unsuitable for drinking purpose but was found seriously polluted.

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