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Evaluation of Physicochemical Characteristics of Suswa River Water in Dehradun, India

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Abstract: ***Water quality of Suswa River in Dehradun was assessed in terms of their Physico-chemical characteristics. Samples were collected on the monthly basis since February to April, 2018 from five sites along the Doon valley. Total number of fifteen samples were collected and pH, Temperature, Alkalinity, Dissolved Oxygen ,Total Hardness , Total Dissolved Solids (TDS) , Salinity , Biological Oxygen Demand (BOD), Calcium and Magnesium concentration were determined . During the course of study minor difference in physical and chemical parameters of the study area were observed.***
Keywords: River pollution, Water Quality, Physicochemical Characteristics, Alkalinity,BOD

I. INTRODUCTION

A River is a natural flowing watercourse usually freshwater, flowing towards oceans, sea, lake, or another river. In some cases a river flows into the ground and becomes dry at the end of course without reaching another body of water. Small rivers can referred to using names such as streams, creek, brook and rill. There is no official definition for the generic term river as applied to geographic features.

There are several rivers within Mussorie -Dehradun region. Various sites were surveyed during the study period. The river Suswa is crossing between the city of Dehradun the river is mostly under the influence of urbanization and in future the situation is worsen and thus the river is selected to be study to check the water quality of the river. The main cause of the river pollution is urban waste, bathing, washing clothes, dumping sewage. This river receives more amount of generals waste and untreated sewage form different sources. It was found heaving high organic status.

Downtown Dehradun city lives between two rivers, Bindal and Rispana. The two rivers that are part and parcel of the city's life are horribly polluted. A few people know that all the dirt and filth that gets collected in these two rivers finally goes into the Ganga. The two rivers after criss-crossing Dehradun city meet the Suswa River at Ramgarh at the Rajaji National Park. The Suswa finally merges with the Ganga. The Suswa, an important tributary of the Ganga, carries all dirt and garbage into the holy river. Our current investigation of the Suswa River water quality was done to study the Physico-chemical characteristics and to assess the various point and diffuse pollution sources of river Suswa in Doon Valley.

II. MATERIAL AND METHODS:

A. Study Area

The Doon Valley lies between two intermittent ranges of the Himalayas, the Outer Himalayas (a.k.a. the Shivalik Hills) and the Lesser Himalayas, known locally as the Mussoorie Range. It is bounded on all sides by mountains, with northern range running from Kalsi in the west to Muni Ki Reti in the east with Mussoorie at the centre in a semi-circular arc; and southern range running at south from Paonta Sahib in the west to Haridwar in the east. The valley also forms a watershed between the Yamuna and Ganges river systems. In fact the Yamuna and Ganges are closest to each other as they pass the Doon valley, with the Yamuna forming the western boundary and the Ganges the east. It runs 75 km long from west to east.

The Doon Valley is ecologically rich, particularly with regard to birdlife, with over 500 bird species having been recorded within the valley and in the surrounding areas, including the Mussoorie Hills and Rajaji National Park. The Reserved Forests and community forests in the region, in and around the valley are also botanically rich in terms of hardwood deciduous forests (esp. Sal or Shorea robusta, and Teak), flowering and fruiting trees, natural wetlands, and Terai and Bhabar ecosystems. Several rivers (e.g. Song, Tons, Suswa and Asan) and a number of lesser streams flow through the valley, having their sources in either the Mussoorie Hills or the Shivalik Hills; all local rivers ultimately flow into either the Ganges or the Yamuna. Other than Rajaji National Park, the local protected areas include Asan Barrage Conservation Reserve and Jhilmil Jheel Conservation Reserve, with the 1000-acre campus of the Forest Research Institute in Dehradun representing another Important Bird Area (IBA)

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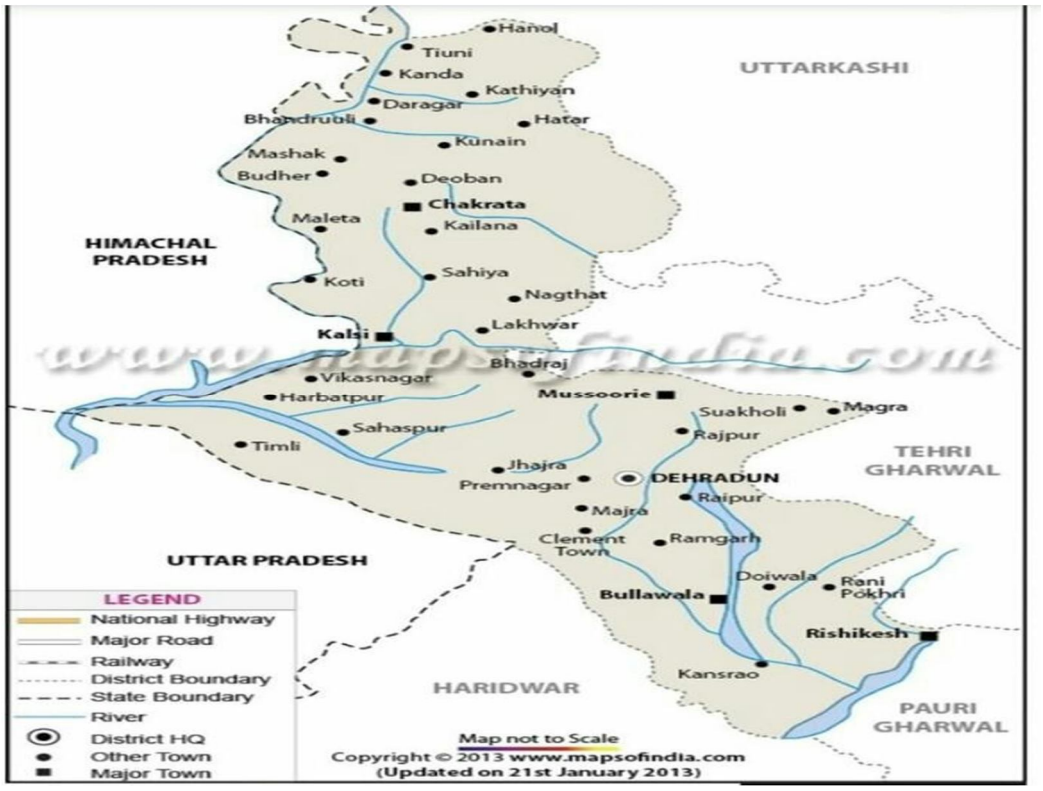


Fig. -1: A view of Doon Valley showing Suswa River.

Suswa River is a spring fed river. It originates from clement town and passing a distance of 36km from reserve forest and as well as from places habitat by human being it merges into river Ganga at Gohri range forest. The Raiwala citizens utilizes the Suswa river for variety of purposes so at some places it receives town effluents and other wastes. These waste changes the Physico-chemical characteristics of this river. Besides this, it adversely affects the ecology of fishes residing there.

B. Sampling Sites

Sl No.	Sampling Stations Code	Sampling Stations Location
1.	Site 1	Clement town
2.	Site 2	Clement town site 2
3.	Site 3	Mothorawala (Confluence Point of Suswa With Rispana and Bindal River)
4.	Site 4	Suswa River After Confluence at Mothorawala
5.	Site 5	Dudhli (Funduwala)

C. Collection & Storage of Water Samples

Water samples were collected from the sites and stored in 1 litre plastic bottles. These samples were taken to the EVS laboratory in BFIT GROUP OF INSTITUTION DEHRADUN, for routine physcio- chemical analysis on the same day. The estimation of dissolved oxygen (DO) was carried out by fixing the same in the sample on the site by adding Winkler's reagent.

All organisms and the communities are directly and indirectly affected by physical and chemical characteristics of river water. These characteristics with natural and manmade changes, determine the quality of water samples was carried out to study the ecological status of the river and the analysis of water samples was done in the Environmental Science Lab. In BFIT Dehradun.

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D. Methodology Applied For Analysis of Water Samples

The water of this river is used for various human activities and so it becomes necessary to check the physcio-chemical characteristics of the same. Monitoring the quality of water is important because clean water is necessary to human health and for the integrity of aquatic ecosystems. For water monitoring, as planned for this study, monthly visits were made; the sampling was done for water quality analysis. The quality analysis for various parameters of the water samples was performed as per standard methods (APHA, 1998),

1) *pH:* It indicate the acidic or basic nature of water. It is one of the most important parameter studied to evaluate the chemistry of water (Ramchandra et al, 2002). The estimation of pH was carried out by dipping the digital pH meter probe (pH scan, Eutech instrument) about 10cm below the surface of water.

a) *Temperature:* The water temperature was recorded by dipping the mercury thermometer up to the desired depth.

2) *Alkalinity:* Alkalinity of water is ability to neutralize a strong acid. The chief component contributing to the alkalinity of most natural freshwaters as carbonates and bicarbonates. This was also estimated by titrimatic method. Total alkalinity is the sum of the hydroxyl alkalinity and bicarbonate alkalinity. Hydroxyl ions present in the samples as a result of dissociation or hydrolysis of solutes reacts with the additions of standard acid. Thus alkalinity depend upon the end point of pH.

3) *Dissolved Oxygen:* DO refers to level of free non-compound oxygen present in water or other liquids. It is an important parameter in assessing water quality because of its influence on the organisms living within a body of water in limnology, D0 is an essential factor second only to water itself. A dissolved oxygen level that is too high or too low can harm aquatic life and effect water quality.

4) *Total Hardness:* The total hardness is the sum of the concentration of the alkaline earth metals cations present in it. Calcium and magnesium are the principal cations imparting hardness. Total hardness was estimated by EDTA titrimetric method. In an alkaline condition, EDTA reacts with Ca++ ang Mg++ to form a soluble chelated complex. They develop wine red colour with eriochrome Black T. Then EDTA is added as a titrant, Ca and Mg divalent ions remains in the solution. At the pH Murexide indicator forms the pink colour with the Ca ions. When EDTA is added Ca ions forms complex resulting in the change from pink to purple, which indicates end point of the reaction.

5) *Total Dissolved Solids (TDS):* Total solids gives the measure of ions dissolved in water. TS is the term applied to the material residue left in the vessel after the evapouration of water sample and its subsequent drying in the oven. Total solids include total dissolved solids (TDS) and total suspended solids (TSS).

6) *Salinity:* Salinity is the saltiness or amount of salt dissolved in water body. Salinity is an important factor in determining many aspects of the chemistry of natural water and biological processes within it, and is the thermodynamics sate of variables that along with temperature and pressure, govern physical characteristics like the density and heat capacity of water.

7) *Biological Oxygen Demand (BOD):* Biochemical oxygen demand or BOD measures the amount of oxygen consumed by microorganisms in decomposing organic matter in stream water. Bod also measures the chemical oxidation of inorganic matter ‘a test is used to measure the amount of oxygen consumed by these microorganism during a specific period of time (usually 5 days at 20^{o} C) the rate of oxygen consumption in a stream is affected by a number of variables like temperature, pH, the presence of certain types of microorganism and the type of organic and inorganic material in the water. BOD directly affect the amount of dissolved oxygen I rivers and streams. The greater the bod the more rapidly the oxygen is depleted in the stream. The main less oxygen is available to higher forms of aquatic life. The consequence of high BOD are the same as those for low dissolved oxygen: aquatic organisms becomes stressed. Suffocate, and die.

8) *Calcium:* The presence of calcium in water results from the passage through or over the deposits of lime stones, dolomites, gypsum, and gypsiferous shale. The calcium content many range from zero to several hundred milligram per liter, depending on the source and treatment of the water. Small concentration of calcium carbonates combat corrosion metal pipes by lying down a protective coating. Appreciably calcium salts on the other hand precipitate on beating to form harmful scale in boiler pipes and cooking utensils.

9) *Magnesium:* Magnesium ranks 8th among the elements in order of abundance and is the common constituent of natural water. Important contributor to the hardness of the water, magnesium salts breakdown when heated forming scales in boilers. Concentration greater than 125 mg/l can also have a cathartic and diuretic effect. Chemical softening reverse osmosis electro dialysis or ion exchange reduces the magnesium and associate hardness to acceptable limits. The magnesium concentration may vary from zero to several hundred milligrams per litres depending upon the source and treatment of the water.

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III. RESULTS AND DISCUSSION

Water samples were collected from five sites of Suswa river and tested for physical and chemical parameters. The important water quality parameters such as pH, Temperature, TDS, DO, BOD, total hardness, calcium magnesium and salinity were analysed. Assessment of the water samples for pollution is made by comparison of the assessed values of Physico- chemical parameters with the corresponding standard prescribed for drinking water by WHO.

A. Temperature

During the study period out of all the sampling site maximum temperature (24.2^0C) observed at sampling site 1 in the month of April and minimum (17.5^0 C)at sampling site 4 in the month of February The water temperature shows upward trend from February to march but slightly decrease in temperature in the month of April.

Table-5.1: Monthly variation of water temperature (^{0}C) at different sites of Suswa River

Sites/Months	Site1	Site2	Site3	Site4	Site5
February	18.8	18.7	17.6	17.5	19
March	23.3	23.4	22.7	23	24
April	24.2	22	23.7	22.6	24

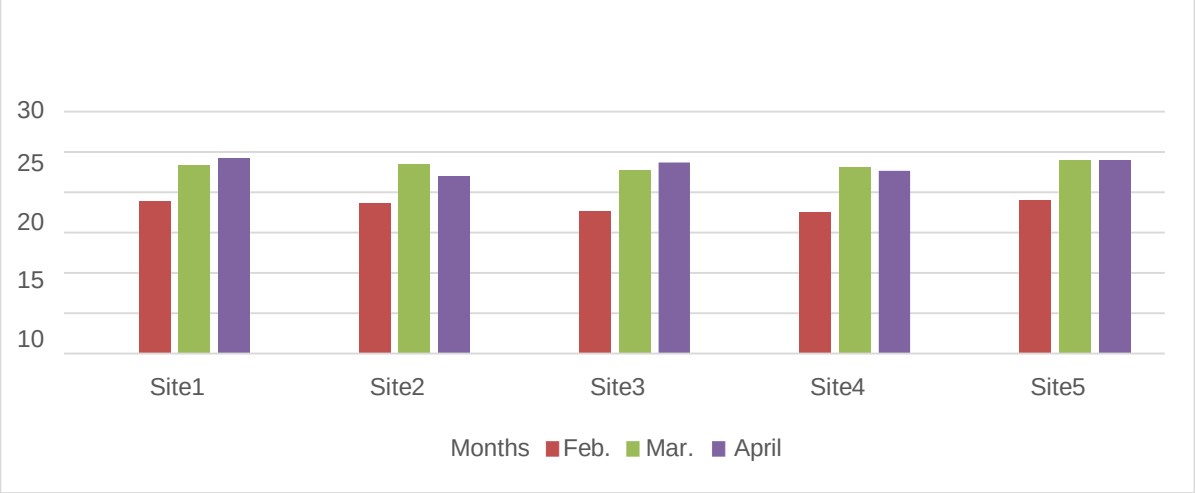


Fig.-3.1. Showing Monthly variation of water temperature (^{0}C) at different sites of Suswa River

B. Conductivity

The conductivity of this study is observed maximum (910 s/cm) at sampling site 2 in the month of Feb. and minimum (631 s/cm) at sampling site 4 in the month of april. The average maximum (896 s/cm) conductivity is observed at the sampling site 1 during entire study period and minimum (778 s/cm) conductivity is observed at sampling site 4.

Table-3.2: Monthly variation of conductivity (s/cm) at different sites of Suswa River

Sites/ months	Site 1	Site 2	Site 3	Site 4	Site 5
February	900	910	890	890	895
March	890	877	869	814	813
April	898	741	673	631	780

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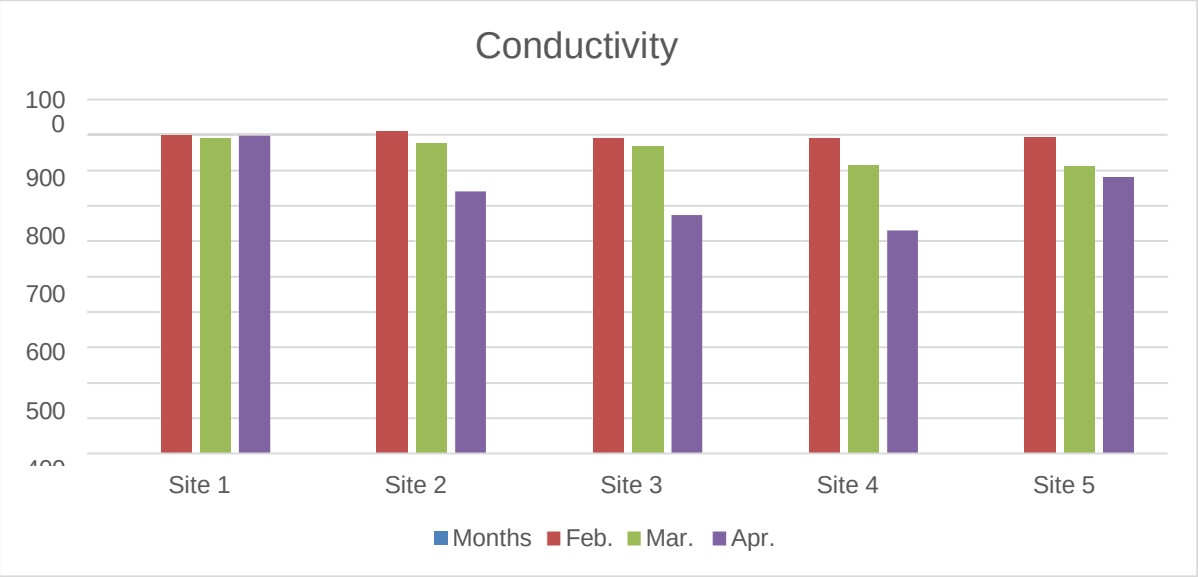


Fig.-3.2. Showing Monthly variation of water conductivity at different sites of Suswa River

C. pH

The pH represent the intensity of acidity or alkalinity of water. It plays an important role in the growth of flora and fauna of aquatic body. In the present study the value of pH observed maximum (7.89) at sampling site 1 in the month of February and minimum at the sampling site (6.23) at sampling site 1 during the study period. The highest maximum average value of pH (7.45) is observed in sampling site 5 and minimum average pHvalue is observed (6.9) at sampling site 2.

Table-3.3: Monthly variation of pH at different sites of Suswa River

Sites/Month	Site 1	Site 2	Site3	Site 4	Site 5
February	7.89	6.88	7.06	7.17	7.5
March	6.25	6.81	7.37	7.25	7.44
April	6.9	7.3	7.4	7.3	7.5

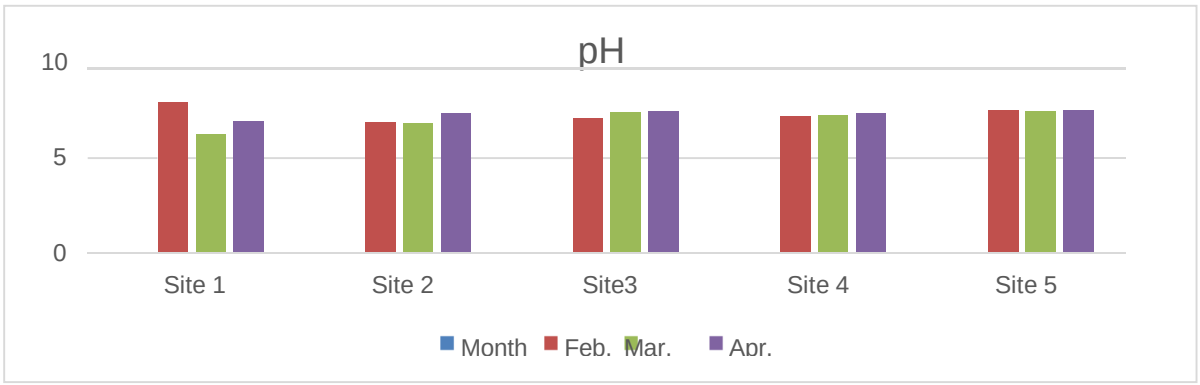


Fig.-5.3. Showing Monthly variation of water pH at different sites of Suswa River

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D. Total Dissolved Solids (TDS)

The value of TDS is observed maximum (642mg/l) at the sampling site 3 in the month of March and minimum (530mg/l) at sampling site 4 in the month of March. The average maximum (599.6 mg/l) value of TDS is observed at sampling site 2 and minimum (538 mg/l) at sampling site 4 during the entire study duration.

Table-5.4: Monthly variation of TDS (mg/l) at different sites of Suswa River

sites/ months	Site 1	Site 2	Site 3	Site 4	Site 5
February	580	600	550	545	570
March	568	574	642	530	541
April	600	625	580	540	570

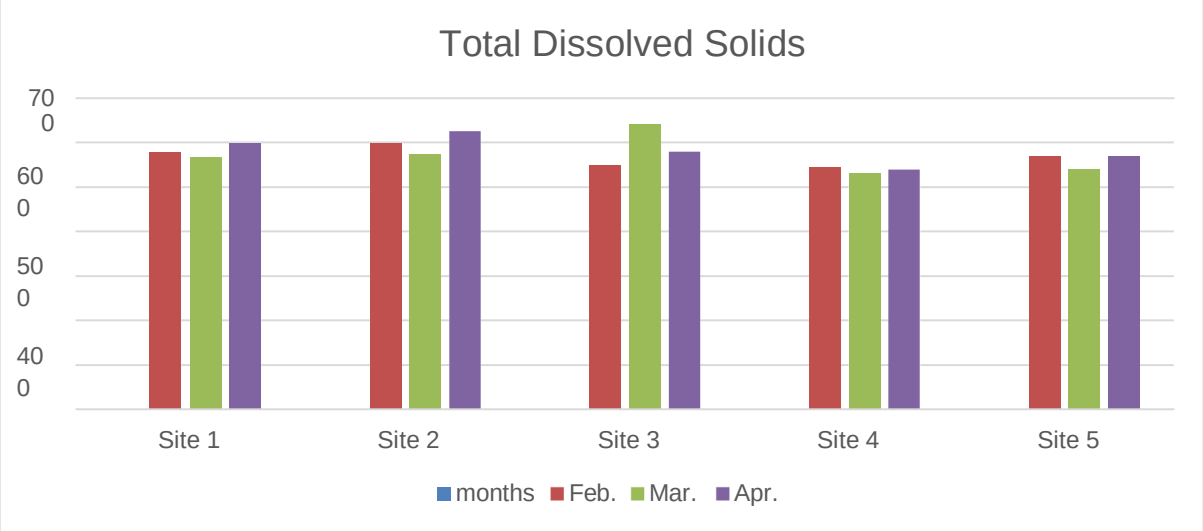


Fig.-3.4. Showing Monthly variation of water TDS at different sites of Suswa River

E. Dissolved oxygen

The maximum (2.8mg/l) value of DO is observed at the sampling site 5 in the month of February and minimum(1.0mg/l) at the sampling site 2 in the month of march . The average maximum (2.2mg/l) DO value is observed at the sampling site 4 and 5 and minimum (1.2mg/l) at the sampling site2 during the whole study periods

Table-3.5: Monthly variation of DO (mg/l) at different sites of Suswa River

Sites/ months	Site1	Site2	Site3	Site4	Site5
February	1.6	1.4	2.6	2.4	2.8
March	1.8	1.0	1.6	2.4	2.2
April	1.6	1.4	1.8	2	1.8

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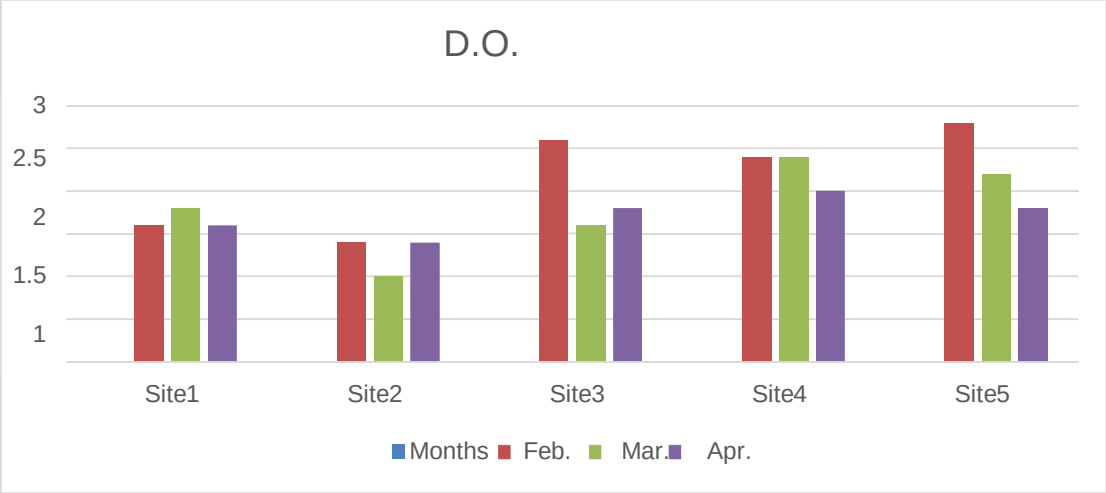


Fig.-3.5. Showing Monthly variation of D.O. at different sites of Suswa River

F. Total Hardness.

The value of total hardness is governed by the content of ca and mg salts largely combined with bicarbonates, sulphate and chlorine . The maximum (90mg/l) observed at site 3 in the month of March and minimum (42mg/l) at the sampling site 5 in the month of April. The maximum (73.3mg/l) average value of total hardness is observed at sampling site3 and minimum (57.3mg/l) at sampling site 1 during the study period.

Table 3.6: Monthly variation of total hardness (mg/l) at different sites of Suswa River

Sites/ months	Site1	Site2	Site3	Site4	Site5
February	50	64	72	58	58
March	72	68	90	78	62
April	50	62	58	68	42

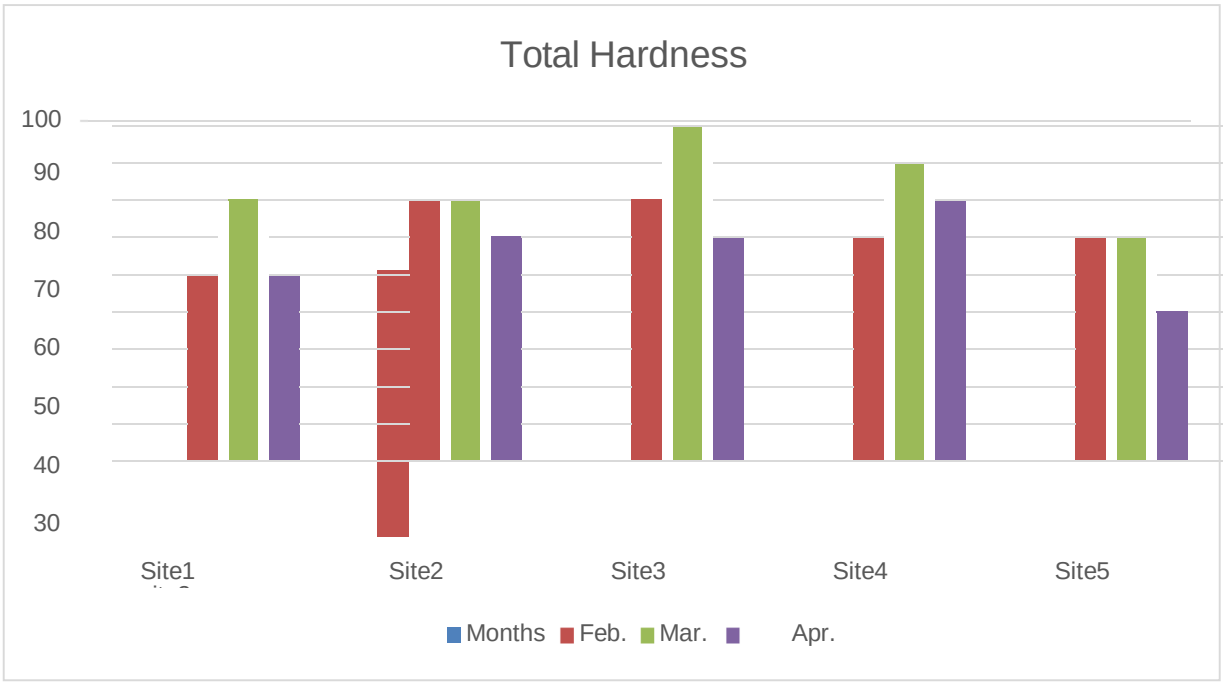


Fig.-5.6. Showing Monthly variation of water Total Hardness at different sites of Suswa River

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G. Alkalinity

Alkalinity is the decrease of carbonates and bi- carbonates. Is showed variation in its value from maximum (60mg/l) to minimum(23.3mg/l) which are observed in sampling site 4 and 1 respectively the maximum value (90mg/l) observed in month of april at sampling site 4 and minimum(10mg/l) in month of february at sampling site 1 during the entire study period.

Table 3.7: Monthly variation of alkalinity at different sites of Suswa River

Sites/ Month	Site 1	Site2	Site3	Site4	Site5
February	10	15	40	20	35
March	20	10	45	70	60
April	40	70	60	90	60

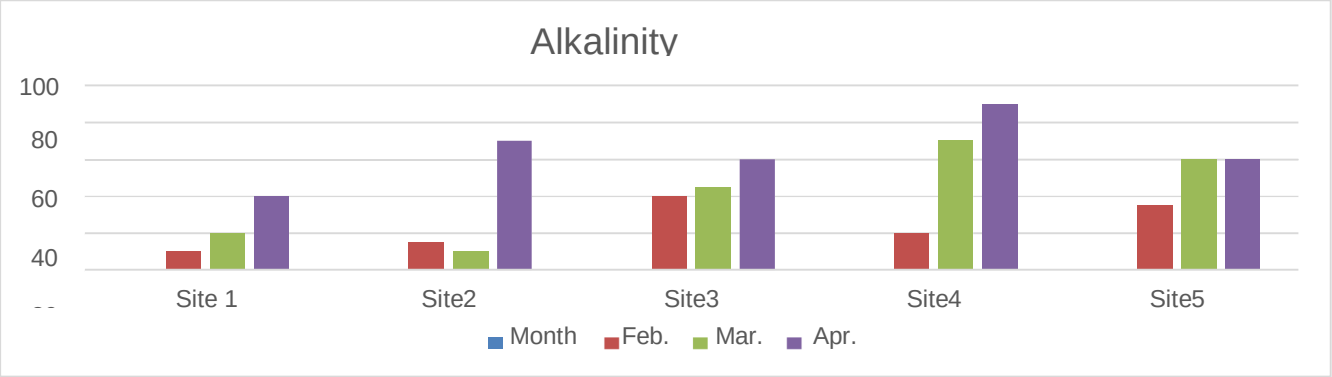


Fig.-3.7. Showing Monthly variation of Alkalinity at different sites of Suswa river

H. Biological Oxygen Demand (BOD)

During this study period the highest (1.6mg/l) and lowest (0.8mg/l) value of BOD was observed at sampling site 3 and 4 respectively. The maximum (1.2mg/l) average value of BOD is observed at sampling site 4 and minimum (0.86mg/l) at sampling site 5 during the entire study period.

Table 3.8 : Monthly variation of BOD(mg/l) at different sites of Suswa River

Sites/ months	Site 1	Site2	Site3	Site4	Site5
February	1.2	1.2	1.6	1.4	0.8
March	1.2	0.8	0.8	1.6	1.0
April	1.0	0.6	1.0	0.8	0.8

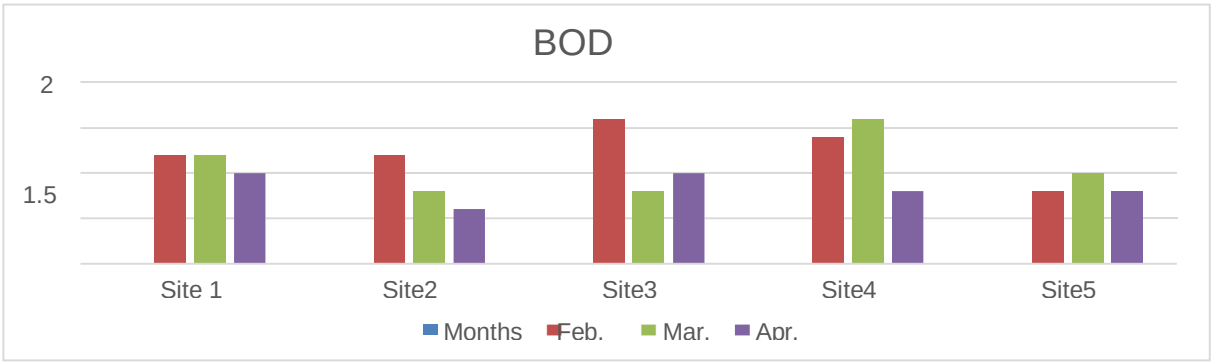


Fig.- 3.8. Showing Monthly variation of water BOD at different sites of Suswa River

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I. Calcium

The maximum (185.32mg/l) value of calcium salt was observed in sampling site 4 in the month of February and minimum (36.9mg/l) observed at sampling site 1 in the month of February. The average maximum value (138.58mg/l) of calcium salt observed at sampling site 4 and minimum value (56.03mg/l) is observed at sampling site 1 during the entire study period.

Table- 3.9: Monthly variation of calcium (mg/l) at different sites of Suswa River

Sites/ months	Site 1	Site2	Site3	Site4	Site5
February	36.9	77.9	125.46	185.32	132.84
March	80.36	141.86	159.08	140.22	137.76
April	50.84	59.86	114.8	90.2	103.32

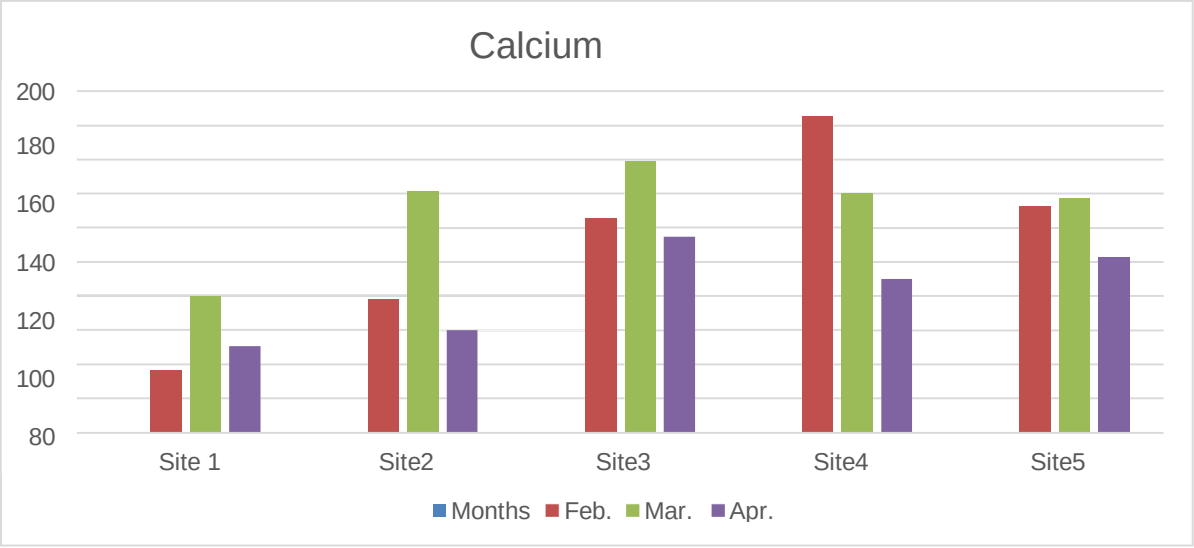


Fig.-3.9. Showing Monthly variation of Calcium at different sites of Suswa River

J. Magnesium

The maximum (118.4mg/l) value of magnesium salt was observed in sampling site 1 in the month of February and minimum (4.62mg/l) was observed at sampling site 3 in the month of march. The average maximum value (92.5mg/l) of magnesium salt observed at sampling site 1 and minimum value (32.82mg/l) observed at sampling site 4 during the entire study period

Table- 3.10: Monthly variation of magnesium (mg/l) at different sites of Suswa River

Sites/ Months	Site1	Site2	Site3	Site4	Site5
February	118.4	100.3	75.64	25.32	92.26
March	69.64	19.44	4.62	14.58	22.84
April	89.46	93.94	42.2	58.6	37.08

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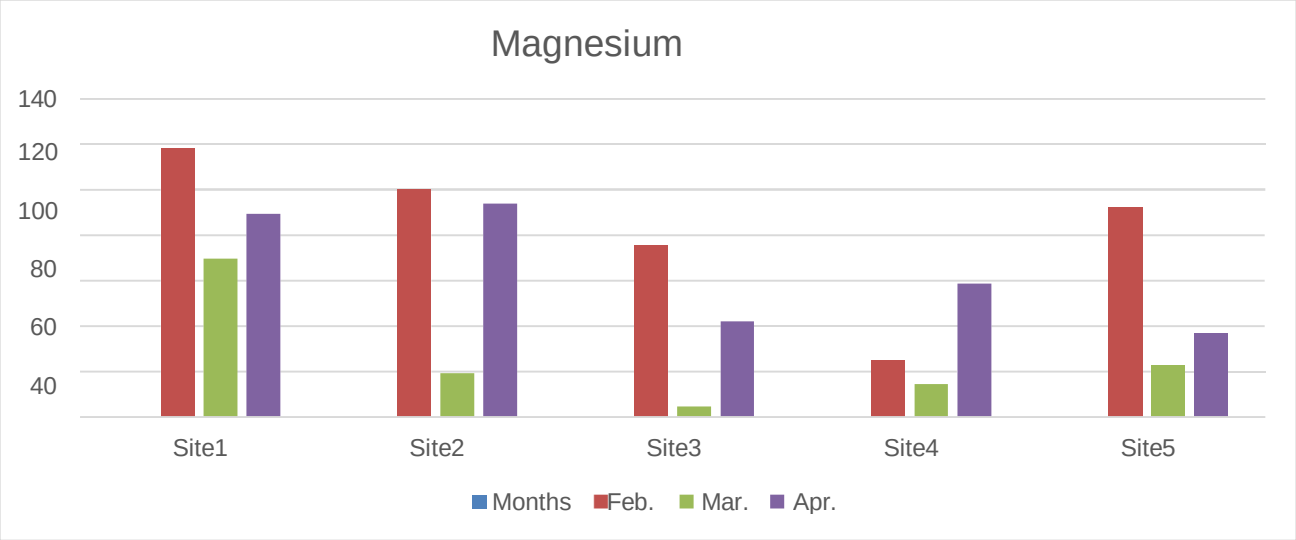


Fig.- 3.10. Showing Monthly variation of Magnesium at different sites of Suswa River

IV. CONCLUSION

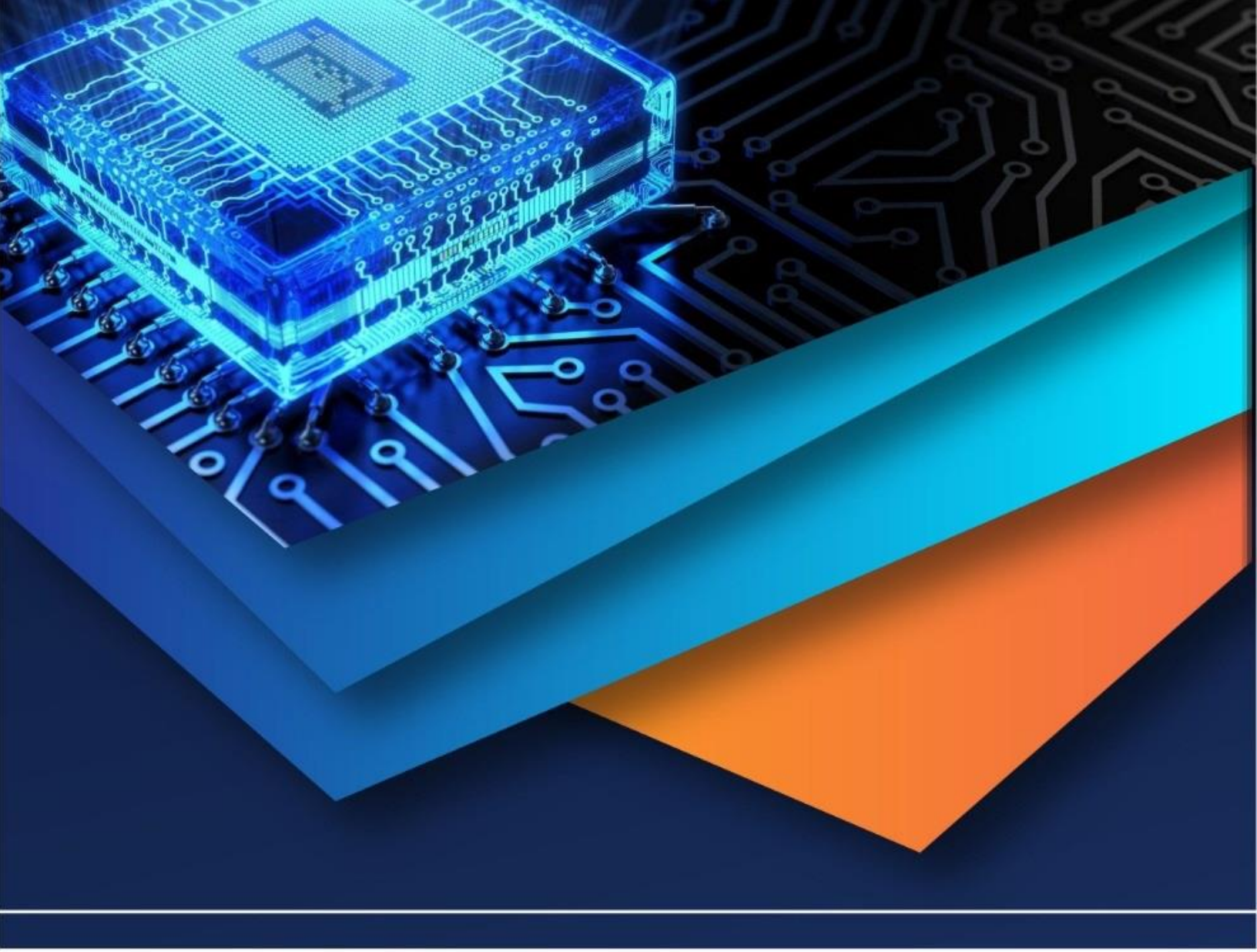
The study reflects the monthly fluctuation of Physico-chemical parameters of Suswa river. Anthropogenic activities affects water quality at sampling site. The water of Suswa river is not suitable for drinking purpose. The study also provides a baseline data water quality management for Suswa river.

Analysis of water samples collected from various sites from the study area reveals that all water samples do not compiles with who standard and Indian standard (IS 10500-90) so the water of Suswa river requires precautionary measures before its use so as to prevent the health effects on human being. Hence we need to monitor these natural resources. Water quality should be done with greater frequency and result should be made public, temporal, environmental and other geomorphic related changes taking place in the river should be monitored.

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