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Comparative study of water quality assessment of Kanke Dam and Dhurwa Dam in Ranchi, Jharkhand, India

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ABSTRACT

The present work deals with a comparative study of the water quality assessment of samples collected from five sites at the Kanke Dam and the Dhurwa Dam in Ranchi. The drinking water is supplied to the major population of Ranchi, which is dependent on the Kanke Dam. It is therefore essential to monitor the water quality at regular intervals of time. Water samples from the various parts of the dams were collected, and analysis was carried out on the basis of various parameters such as pH, conductivity, total dissolved solids (TDS), total alkalinity, total hardness, calcium, magnesium, chloride, dissolved oxygen, and biological oxygen demand. The range of various water quality parameters in both areas understudied were pH (7.19-7.45), conductivity (114.8-445.6 s/cm), total dissolved solids (67.42-267.3 mg/L), total alkalinity (43-147 mg/L), total hardness (64.8-145 mg/L), calcium (7.85-52.8 mg/L), magnesium (3.54-11.70 mg/L), chloride (6.79-54.90 mg/L), and DO (3.40-8.40 mg/L) and BOD (2.10-2.80 mg/L) were also measured. The study revealed that some analytical aspects were higher than the prescribed limit by the WHO and BIS standards for drinking water quality. The methodology for water quality assessment was taken from BIS and APHA standard methods. Some of the sampling sites at the dams can be categorized as "hypereutrophic," which indicates the water at that site is unfit for domestic use. The outer skirt of the dam has shrunk considerably due to the aggressive rapid urbanization process and uncontrollable encroachment. We need to spread awareness among people in order to keep these bodies of water free from pollution

Key Words - Water Quality Assessment, Kanke & Dhurwa dam, Turbidity, BOD, BIS standard methods, Encroachment

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INTRODUCTION

Clean Water is very essential for healthy survival of all the living things. Drinking water should be free from any pollutants for good health and productive life. It is very necessary to monitor the Water Quality in order to provide the clean and safe water to an individual and a community. Therefore, it is necessary to assess the quality of water at regular interval of time. The present situation of the most of the water bodies are not so good to use for drinking purposes. The water is being polluted by the various anthropogenic activities such as domestic Sewage, automobile washing, agricultural run-off etc. are released into these water bodies, leading water pollution. Excess release of domestic sewage containing mainly phosphate and nitrate leading a water body to eutrophication. Currently there are no big industries in and around the study areas, but household waste, Municipal sewage and agricultural run-off are directly released into the area understudied. Thus, the comparative study of physicochemical parameters of sample taken from the various locations are carried out to monitor the level of pollution time to time in order to provide clean and safe water to the nearby locality and community after water treatment. There are many uses for fresh water resources, including agricultural, domestic, recreational, and environmental ones.

Access to clean water is crucial for the survival of all living organisms and is necessary for sustaining ecosystems (UNESCO, 2003). Poor water quality can lead to a variety of health problems and negatively impact the quality of life (Nabila *et al.*, 2014). Anthropogenic activities such as domestic sewage, agricultural runoff, and automobile washing release pollutants into water bodies, leading to water pollution (John Mohammad *et al.*, 2015). The release of excess domestic sewage, containing mainly phosphate and nitrate, can lead to eutrophication (Pavan Kumar *et al.*, 2013). Therefore, regular monitoring of water quality is essential to provide clean and safe water to individuals and communities (Nabila *et al.*, 2014).

Dams are built across streams to impound water and control soil erosion (Gupta, 2009). It is important to assess whether water from dams is suitable for drinking and irrigation to meet future needs (Gupta, 2009). Monitoring the water quality in aquatic systems like reservoirs is necessary for river basin planning and management (Pavan Kumar *et al.*, 2013).

Water quality is influenced by various factors such as inputs from the soil, atmosphere, weathering of rocks, and pollution sources (USEPA, 1974). The concentration of dissolved salts in the water, such as Na, Ca, Mg, and HCO_3, affects the amount of irrigation required and the quality of the water (USEPA, 1974).

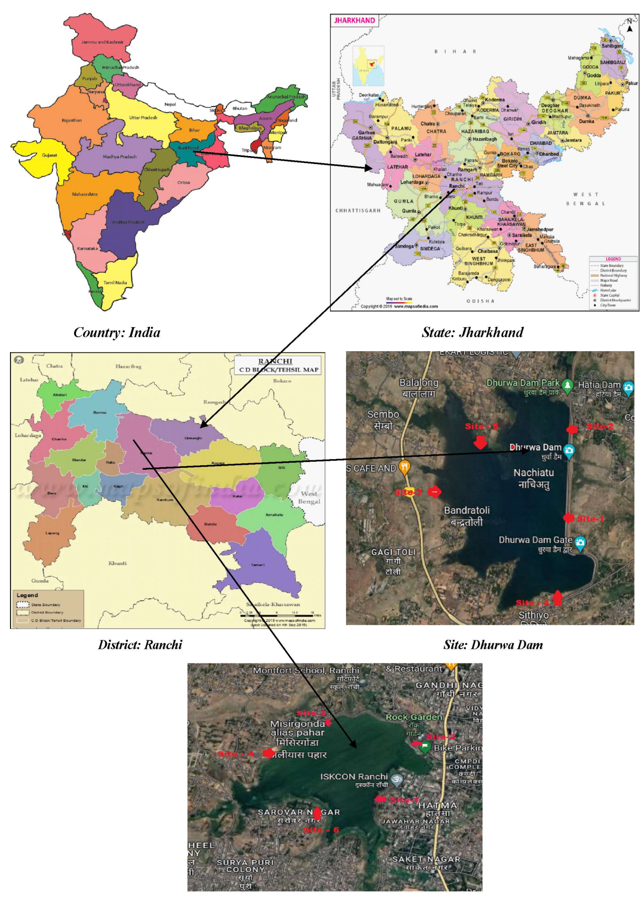
Comparative studies of reservoir water quality have been conducted globally, including studies on Stanley Reservoir (Sreenivasan, 1966), Sardar Sagar (Sreenivasan, 1979), Laxmi tall and Attiya taal ponds in Jhansi town (Arya, 2011; Kumar, 2011), underground water analysis in Jhansi city (Arya, 2011), Gwalior city (Parihar, 2012), and Sama-pond (Parikh & Mankodi, 2012). These studies are important in understanding the quality of fresh water resources for various uses, including agricultural, domestic, recreational, and environmental purposes (Bhadja, Vaghela *et al.*, 2013; Choudhary *et al.*, 2011; Janeshwar *et al.*, 2012; Swaranlatha *et al.*, 1998; Pandey *et al.*, 1993).

MATERIAL & METHODS

Study Areas

Both the dams under studied are situated at Ranchi, Jharkhand, India and these are well known water reservoirs used to supply water to the locals for domestic purposes. That's why these water bodies were chosen for the comparative study of their water qualities on the basis of various physical and chemical parameters.

Kanke Dam is a major water reservoir from where water is supplied to the surrounding areas of



Ranchi. Kanke dam is located at latitude 23.3999°N, 85.3046°E. It is 4 km away from the main city of Ranchi. The Dhurwa dam is also a major reservoir from where water is supplied to the local people. This dam is located at latitude 23.2898°N, 85.2490°E. The five sites were selected for the sampling namely as, Site - 1, Site - 2 and Site - 3, Site - 4 and Site - 5 which were indicated in the map of Kanke and Dhurwa dam in figure-1.

RESULT & DISCUSSION

The water quality of Kanke and Dhurwa Dam were assessed on the basis of analysis of physical and chemical parameters. The Sample were collected into the plastic bottle in day hour and were analyzed using the American Public Health Association (APHA) and BIS (Bureau of Indian Standards) methods. The various water quality parameters are discussed and summarized by these figures mentioned in table-1:

Table 1: Obtained result of various water quality parameters of the Kanke and Dhurwa dam

Sl. No.	Parameters	Kanke Dam						Dhurwa Dam					
		Site 1	Site 2	Site 3	Site 4	Site 5	Avg.	Site 1	Site 2	Site 3	Site 4	Site 5	Avg.
1	**pH**	7.27	7.31	7.22	7.45	7.39	**7.32**	7.23	7.45	7.19	7.26	7.17	**7.26**
2	**Conductivity, (µs/cm)**	437.2	441.5	432.1	445.6	443.9	**440.0**	114.8	116.5	115.2	117.4	115.9	**115.9**
3	**Total dissolved solids (TDS), (mg/L)**	262.4	259.7	265.2	267.3	258.9	**259.7**	68.88	69.94	67.42	67.48	68.95	**68.53**
4	**Total Alkalinity, (mg/L)**	145	147	143	147	146	**145.6**	45.0	47.0	44.0	46.0	43.0	**45.0**
5	**Total Hardness, (mg/L)**	142	140	145	144	142	**142.6**	66.0	69.4	64.8	68.2	67.9	**67.26**
6	**Calcium, (mg/L)**	50.4	49.8	52.8	51.7	50.9	**51.12**	8.00	8.26	7.85	8.14	7.96	**8.04**
7	**Magnesium, (mg/L)**	3.84	3.72	4.32	3.54	3.54	**3.79**	11.04	11.70	10.84	11.48	11.52	**11.31**
8	**Chloride, (mg/L)**	54.0	53.2	54.9	51.4	52.8	**53.26**	7.00	7.25	6.97	6.79	7.15	**7.03**
9	**Dissolved Oxygen (DO), (mg/L)**	3.20	3.00	3.40	3.30	3.20	**3.22**	8.20	8.40	8.10	8.32	8.26	**8.25**
10	**Biological Oxygen Demand (BOD), (mg/L)**	2.60	2.80	2.50	2.70	2.50	**2.62**	2.30	2.10	2.50	2.20	2.40	**2.3**

1. pH

pH is defined as the power of hydrogen or hydronium ion concentration. It determines either the water is acidic or alkaline in nature. The normal range of pH should be between 6.5 to 8.5 for domestic use of water. The pH values of water sample from the Site-1, 2, 3, 4 and 5 of Kanke Dam were investigated 7.27, 7.31, 7.22, 7.45 and 7.39 respectively with average value of 7.32 while the pH values of the same of Dhurwa dam were obtained 7.23, 7.45, 7.29, 7.26, and 7.17 respectively and the average value was 7.26.

2. Conductivity

Conductivity of water is the ions formation in a water body having the conduction efficiency of electron, heat and sound. The limit of conductivity should be in the of 200 -800 µs/cm. As per the water samples analyzed and mentioned in the Table-1 the conductivity of the water samples of Kanke dam ranges from (432.1 - 445.6) µs/cm and average value obtained was 440 µs/cm, while the sample 7collected form Dhurwa dam were ranges from (114.8 - 117.4) µs/cm, and the average value obtained was 115.9 µs/cm.

3. Total dissolved solids (TDS)

TDS is an indicator of the overall saltiness of water and reflects the level of inorganic contaminants present in the water system. Essentially, TDS measures the amount of dissolved particles in a specific volume of water. TDS can arise from both natural and human-made sources. Natural sources include lakes, rivers, plants, and soil, while human activities such as agricultural runoff can also contribute to TDS by introducing chemicals and herbicides into water bodies. TDS observed of the samples collected from the Kanke dam were ranged from (258.9 - 267.3) mg/l while that of the Dhurwa dam were found from (67.42 - 69.94) mg/l. The average value of the TDS of Kanke and Dhurwa dam were 259.7mg/L and 68.53 mg/L respectively.

4. Total Alkalinity

Water's ability to neutralize is referred to as its alkalinity. The sample collected from the five sites of the Kanke dam were analyzed in the laboratory and resulted 145 mg/L, 147 mg/L, 143 mg/L, 147 mg/L & 146 mg/L and that of the Dhurwa dam were obtained 45 mg/L, 47 mg/L, 44 mg/L, 46 mg/L & 43 mg/L respectively. The average result obtained from the various sites of Kanke and Dhurwa dam were 145.6 mg/L and 45 mg/L

5. Total Hardness

In terms of hardness, calcium and magnesium concentrations are added together and given as calcium carbonate in milligrams per liter (mg/L). Since calcium and magnesium are naturally present in the Earth's crust, water that is considered to be "hard" contains significant amounts of these minerals. The amount of calcium and magnesium present in the water is calculated, and this value is then converted to the equivalent amount of calcium carbonate ($CaCO_3$) in milligrams per liter (mg/L) of water. The following categories are used by the Canadian Drinking Water Quality Guidelines to classify hardness:

Hardness Category	Equivalent Concentration of $CaCO_3$
Soft	< 60 mg/L
Medium hard	60 mg/L to <120 mg/L
Hard	120 to <180 mg/L
Very Hard	180 mg/L or greater

The water sample collected from the Kanke dam were analyzed 142 mg/L, 140 mg/L, 145 mg/ L, 144 mg/L and 142 mg/L as of $CaCO_3$ respectively while that of Dhurwa dam were resulted 66 mg/L, 69.4 mg/L, 64.8 mg/L, 68.2 mg/L & 67.9 mg/L. The average value of hardness was calculated 142.6 mg/L and 67.26 mg/L as of $CaCO_3$. Thus, the water of the Kanke dam was considered more hardness due to extreme release of sewage into the water body as compare to the other water body.

6. Calcium

Water naturally contains calcium, which is mainly present due to its occurrence in the earth's crust and coral. Calcium concentration in rivers is typically 1-2 ppm, but it can reach up to 100 ppm in areas with high lime content. Almost all living organisms, except for a few microorganisms and insects, require calcium in their diets. Marine animal bones and eye lenses are composed of calcium carbonate, while terrestrial species require calcium phosphate for their bone and tooth structure. Calcium is the primary cause of water hardness, which can affect the toxicity of other substances in the water. In soft water, toxic elements such as copper, lead, and zinc are more hazardous. High levels of iron in the soil can lead to ion deficiencies. Water hardness also has an impact on metal toxicity for aquatic species, with softer water causing an increase in membrane permeability in the gills. Calcium competes for binding sites with other ions in the gills. Water hardness can also lead to the hardening of household appliances due to carbonate hardness caused by high temperatures. This can significantly reduce the lifespan of equipment and increase waste generation. Calcium carbonate also reacts with cleaning solutions and detergents. The average value of the Calcium analyzed of the sites of the Kanke and Dhurwa dam were 51.12 mg/L and 8.04 mg/L respectively.

7. Magnesium

Magnesium concentrations in most bodies of water range from 1 mg/L to 40 mg/L. There is a correlation between the calcium to magnesium ratio in natural water. The ratio ranges from 4:1 to 2:1 in water with total dissolved solids (TSD) less than 500 mg/L. The concentration of magnesium will be several times greater than that of calcium if the TSD rises further. Alkaline water has a higher magnesium content than calcium because the chloride and sulphate of magnesium have a higher degree of hydrolysis than calcium does. The Magnesium found averagely 3.79 mg/L in water of Kanke dam while it was 11.31 mg/L in Dhurwa dam.

8. Chloride

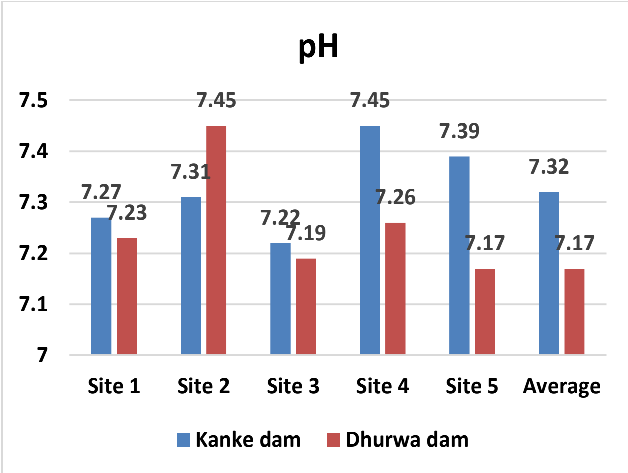
Chloride ions are naturally present in both freshwater and saltwater. They are mainly derived from dissolved salts such as sodium chloride and magnesium chloride. Chloride is essential for the normal cellular activity of both plants and animals, but only in small amounts. In small quantities, chloride can also be used as an indicator of human wastewater discharges or other contaminants. Chloride concentrations in natural groundwater that comes from rainwater can be less than 10 mg/L. However, chloride concentrations in groundwater can increase to 20 or 30 mg/L or more due to the discharge of wastewater onto land surfaces or leaching from chemical fertilizers used in agricultural soils. Although these concentrations do not affect the taste of water, they can be examined in groundwater samples to identify pollution and determine potential sources. Typical sources of contamination include fertilizers, septic systems, and animal manure. High concentrations of chloride in freshwater can harm aquatic animals by disrupting osmoregulation, the biological process by which they regulate the right concentration of salt and other solutes in their body fluids. The chloride concentration was analyzed in the water samples averagely 53.26 mg/L in Kanke dam and 7.03 mg/L in Dhurwa dam.

9. Dissolved Oxygen

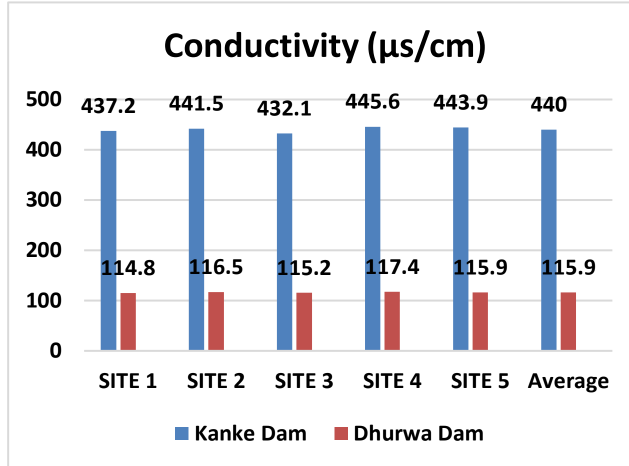
The amount of oxygen that is dissolved in the water, or the amount of oxygen that is available to living aquatic organisms, is measured by the term "Dissolved Oxygen" (DO). In locations where groundwater discharge into streams makes up a significant component of stream flow, oxygen reaches streams primarily from groundwater discharge. Fish and zooplankton both breathe this dissolved oxygen, which is essential for their survival. The Dissolved Oxygen were observed and analyzed on an average 3.22 mg/L in Kanke Dam and 8.25 mg/L in Dhurwa dam. The DO was very less making the water body extreme polluted and an Asphyxiation condition could be occurred in future which could be dangerous for the sustenance of aquatic life of the Kanke dam as compared to Dhurwa dam.

10. Biological Oxygen Demand

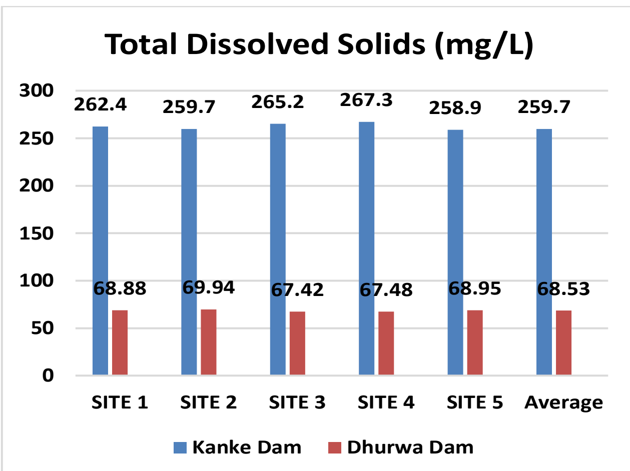
The term "BOD" has a double meaning, referring to both the average oxygen demand for organic waste that can be degraded aerobically and the amount of molecular oxygen required for the biological oxidation of organic materials in water. The assessment of stream pollution control and the evaluation of a stream's self-purification potential both benefit from biological oxygen demand tests. The BOD measures the amount of oxygen that aerobic bacteria need to decompose biodegradable organic matter into various byproducts. A low BOD indicates low levels of organic matter content and microbiological organisms in the water. BOD tests are an excellent indicator of water quality in terms of oxygen concentration. The Biochemical Oxygen Demand (BOD) is a crucial indicator to assess water quality, representing the amount of biodegradable organic material present in the water. If the BOD level exceeds the permissible limit, mitigation cannot be done promptly. Aquatic life is severely impacted when the BOD of a body of water rises considerably. The bacteria that decompose organic waste considerably reduce the amount of oxygen that aquatic species require for respiration and metabolism, leading to the death of fish and aquatic vegetation and disrupting the aquatic ecosystem. Freshwater fish species like Catla and Rohu cannot survive in such conditions. The overall aesthetic appeal and beauty of the water body is significantly diminished. The quality of water bodies is drastically declining due to increasing pollution and urbanization. Direct discharge of untreated sewage into water bodies was common, resulting in severe pollution and an increase in BOD. Additionally, water-borne illnesses, such as cholera, dysentery, and jaundice, increased due to this. The BOD level in the water of Kanke dam were analyzed 2.62 mg/L while 2.30 mg/L in Dhurwa dam.



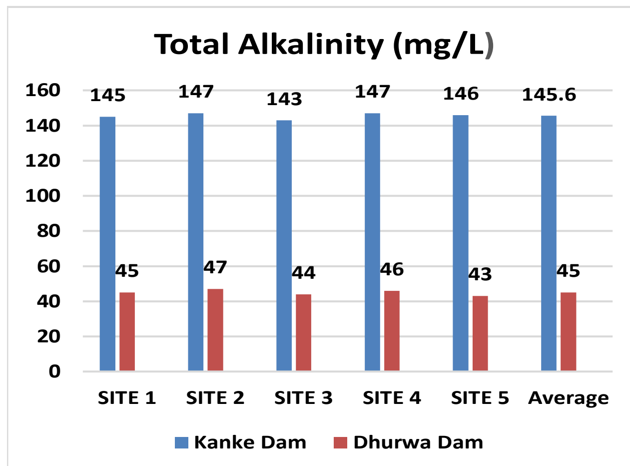
Graph 1: pH



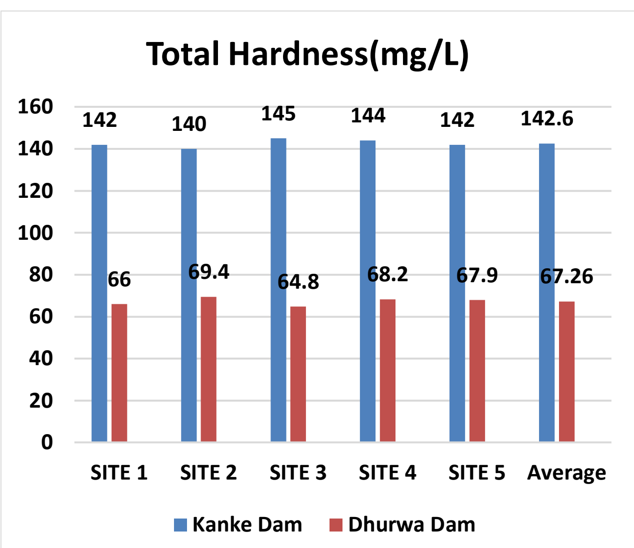
Graph 2: conductivity



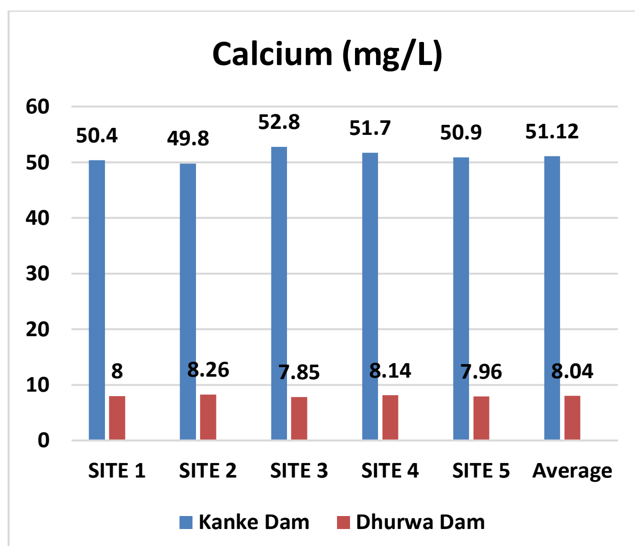
Graph 3: TDS



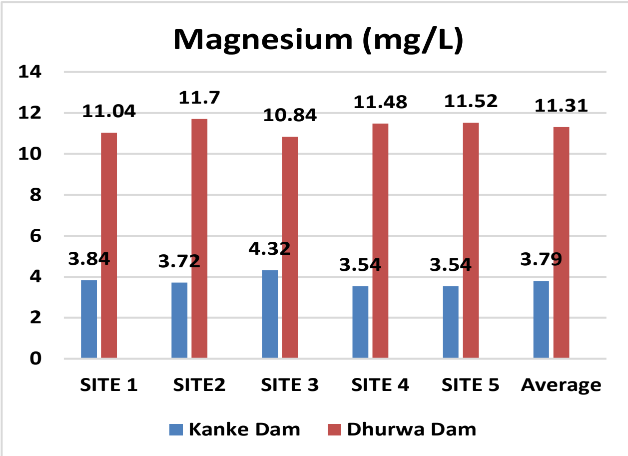
Graph 4: Total Alkalinity



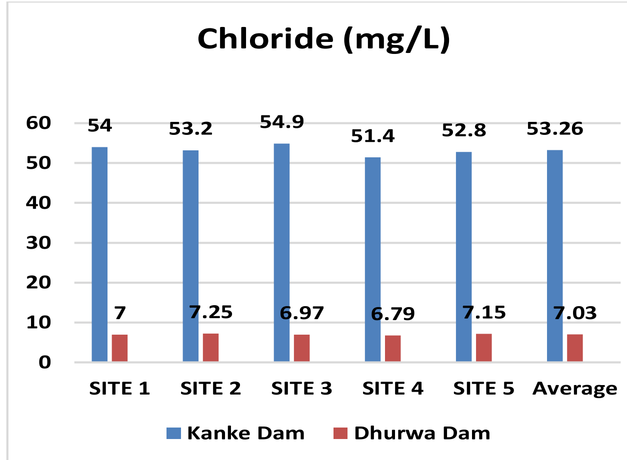
Graph 5: Total Hardness



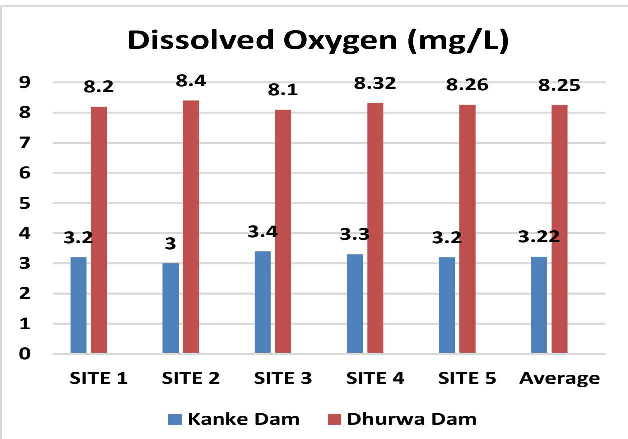
Graph 6: Calcium



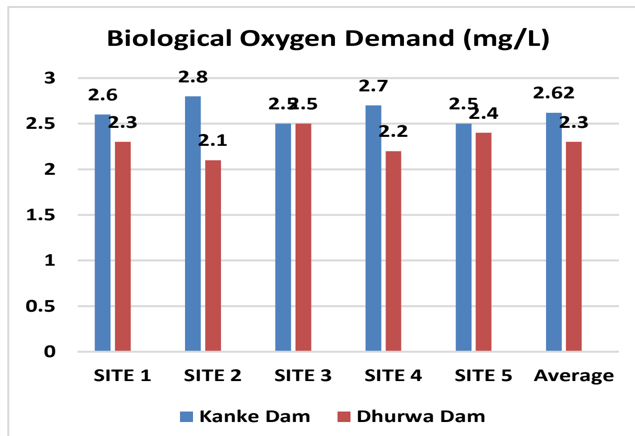
Graph 7: Magnesium



Graph 8: Chloride



Graph 9: Dissolved Oxygen



Graph 10: BOD

CONCLUSION

On the basis of the water quality, different parameters were assessed, of both the areas under studied. It was found that the water quality of the Kanke dam was more polluted and unfit for domestic use in comparison to that of the Dhurwa dam. The concentration of TDS, Total Alkalinity, Total Hardness Calcium and Chloride were more in the water of Kanke dam than that of Dhurwa dam. Also, the Dissolved Oxygen is very less in Kanke dam than that of the Dhurwa dam which indicated the pollution load in Kanke dam. The reason of pollution in the water body of Kanke dam was due to the direct sewage discharge without prior treatment and encroachment in the outer skirt of the dam. Thus, the water quality of the Kanke dam was more polluted than the Dhurwa dam.

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