

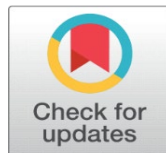
EVALUATION OF WATER POLLUTION STATUS OF TRIYUGA RIVER IN UDAYAPUR DISTRICT, NEPAL

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ABSTRACT

The present investigation has been conducted to assess the status of physiochemical and microbiological parameters to understand the present scenario of water quality at Triyuga River water at Belaka municipality of Udayapur district, Nepal. The temperature ranged from 18°C to 20°C, the TDS value ranged from 89 mg/L to 112 mg/L and were below the WHO guideline value of 1200 mg/L, the pH values of the surface water sources in the present study were found to be alkaline ranging above from 7.6 to 7.9 were found within the range of WHO guideline value of 6.5-8.5. Similarly the values of dissolved oxygen ranged from 6.4 mg/L to 10.4 mg/L and were above the WHO guideline value of 5 mg/L, the bicarbonate (HCO₃) value ranged from 105 mg/L to 125 mg/L and were below the WHO guideline value of 125-350 mg/L, the values of Nitrate ranged from 3 mg/L to 5 mg/L and were below the WHO guideline of 50 mg/L, the values of Nitrite ranged from 0.3 mg/L to 0.5 mg/L, the value of Ammonium ranged from 0 mg/L to 0.3 mg/L, the values of Iron ranged from 1 mg/L to 1.5 mg/L and were above the WHO guideline of 0.3 mg/L and the phosphate was not detected in all the three different sites of surface water samples. The fecal coliform was found to be positive in all the samples and the value of fecal coliform recorded was 15, 15 and 21 MPN/100ml in Site I, II and III respectively.

Keywords: Belaka Municipality, Microbiological, Physiochemical, Pollution, Triyuga River, Surface Water

1. INTRODUCTION

All life, including that of humans, animals, and plants, depends on water. It sustains all facets of human livelihoods and is necessary for the general well-being of humans. Water is also essential for the maintenance of productive human endeavours like fishing, tourism, transportation services, sanitation, and the production of food, energy, and industrial goods [UNEP \(2009\)](#). According to [Hema & Subramani \(2013\)](#), rivers are the primary sources of fresh water for all human

activities. Rivers are the main source of freshwater and have long been utilized for energy production, transportation, irrigation, waste water transportation, and municipal water supply [Isken et al. \(2008\)](#). Water is a fundamental component of all living things' fluids, including rain, streams, lakes, and oceans. It is also a prerequisite for human and industrial development [Das & Chaudhary \(2021\)](#).

Any physical, chemical, or biological alteration in the quality of water that endangers life or renders the water unfit for intended uses is referred to as water pollution [Miller \(2002\)](#). One of the most important environmental problems facing the world today is water pollution. When contaminated water serves as a medium for the spread of illness, it is accountable for a great deal of the mortality of various organisms. Diseases linked to water and sanitation claim thousands of lives worldwide [WHO \(2010\)](#).

Owing to its paramount significance, numerous investigations concerning the quality of surface water have been conducted in various parts of Nepal, including the Bagmati River in the Kathmandu valley [Karn & Harada \(2001\)](#), Kodku Khola, Lalitpur [Maharjan \(2006\)](#), Sirsiya River of central southern Nepal [Shah & Pant \(2013\)](#), Gosainkunda Lake [Raut et al. \(2013\)](#), Bagmati River in Kathmandu Valley [Gautam et al. \(2013\)](#), Kolpu Khola in Sisdol Landfill Area of Nuwakot District [Shrestha et al. \(2015\)](#), Chimdi in Sunsari district [Das \(2017\)](#), Pokhara lake [Das \(2017\)](#), Betana wetland in Morang [Das et al. \(2018\)](#), Sanbarish Pond of Morang District [Das et al. \(2020\)](#), Lakes of Chitwan National Park, Central Nepal [Bhusal & Devkota \(2020\)](#) and Rara Lake [Kaphle et al. \(2021\)](#). Keeping these aspects into consideration, the present study has been designed to assess the Triyuga river water on the basis of physicochemical characteristics.

2. MATERIALS AND METHODS

2.1. STUDY AREA

The study area is situated at latitude 26°54'25.56" N and longitude 86°40'40.80" E in the Udayapur district of eastern Nepal. The district has a total area of 2,063 km², with Gaighat (Tiryuga) serving as its headquarters. There are 317,532 people living in the Udayapur district. There are four urban and four rural municipalities in the Udayapur district. The district is situated between 360 and 2310 meters above sea level.

Figure 1

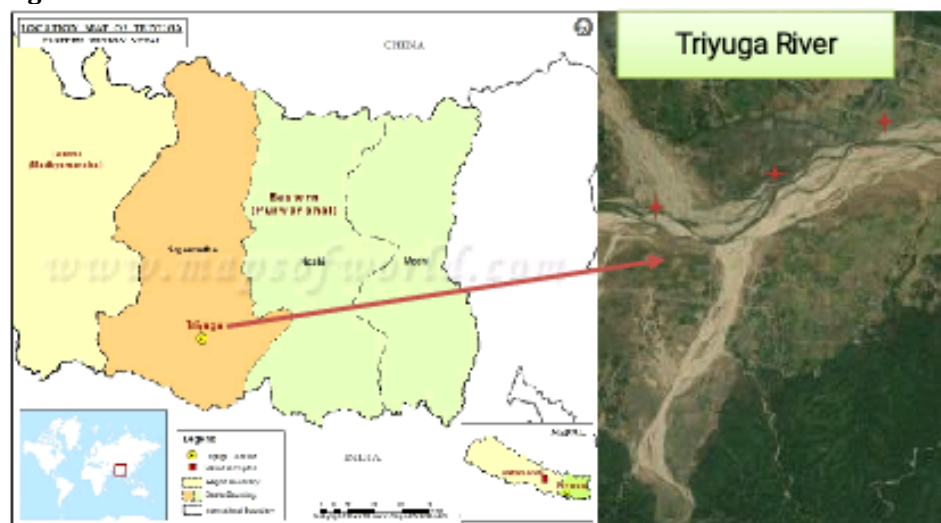


Figure 1 Map of the Study Area (Tiryuga River)

The Trijuga (or Triyuga) River Basin is situated in Nepal's Udaypur district, on the Terai and Siwarik borders. The river basin is close to important national transit hubs, where burgeoning trade and commerce with India are conducted both domestically and internationally. In certain areas of the Basin, industrial development, irrigation projects, and traditional fishing operations are currently underway, suggesting that the region has more potential to contribute to the nation's economic growth. As a result, the Trijuga River Basin was given top priority in the government of Nepal's 2019–2020 policies and programs. All of the aforementioned development and the basin's overall sustainable progress will be determined by the mitigation of the frequent flooding and other water-related disasters that have occurred in the basin [Workshop-Trijuga River Master Plan-GWP \(n.d.\)](#).

2.2. DATA COLLECTION

Samples of river water were taken between the hours of eight and eleven in the morning and placed in plastic bottles that had been cleaned with distilled water before being sent to the departments of microbiology and botany at the MMAM campus in Biratnagar, Nepal. Important chemical variables like Dissolved oxygen, Iron, Total Alkalinity, Nitrate-nitrogen, Nitrite, phosphate-phosphorus, ammonium-ammonia, and iron were examined. Using a multi-parameter water quality monitoring instrument (HANNA), certain water variables, such as temperature, pH, and TDS, were estimated immediately following the collection of water samples. The Modified Winkler Method was used to measure dissolved oxygen (DO), the Phenol Disulfonic Acid Method was used to measure nitrate-nitrogen (NO₃-N), and the Stannous Chloride Method was used to measure phosphate-phosphorus (PO₄-P). Ammonium, Iron and Arsenic were determined with the help of 'Field Test Kits', methods. Water samples were collected and analyzed following the standard protocol [APHA \(2005\)](#).

3. RESULTS AND DISCUSSION

The samples were analyzed during the period of post-monsoon 2020. The physiochemical and bacteriological parameters of three different sites of water measured during the study period. All the results are enumerated in the table1 and [Figure 2](#).

Temperature

The surface water temperature at sites I, II, and III varied from 18°C to 20°C, with an average of 18.66°C degrees. The temperature values recorded at each sampling site fall within the WHO's permissible limit, which is 12-25°C for drinking water. Warmer water than colder water promotes growth and can exacerbate corrosion issues as well as taste, odor, and color issues [WHO \(2008\)](#).

Total dissolved solid (TDS)

The average TDS was 101.66 mg/L, with TDS ranging from 89 mg/L to 112 mg/L from sites I, II, and III, respectively. All of the total dissolved solid values fell short of the 1200 mg/L WHO guideline. Total dissolved solid is a measurement of all the organic and inorganic materials that have been dissolved in a specific amount of water. Total dissolved solids have an impact on how pure and suitable the water is for irrigation and drinking. A high concentration of dissolved solids raises the density of water, affects the osmoregulation of freshwater organisms, decreases the

solubility of gases, and decreases the use of water for industrial, agricultural, and drinking purposes [Saxena \(1989\)](#).

Hydrogen- ion- concentration (pH)

The pH values of sites I, II, and III ranged from 7.5 to 7.9, with an average pH of 7.66 and it was generally found to be alkaline, with values above 7.0 falling within the WHO drinking water standard range. It was discovered that the majority of the pollution at Site 3 during the study period came from dumping of municipal and residential waste. Because of the organic matter's breakdown, Site 3's pH is now acidic. The pH of the water at the disposal site can be greatly impacted by the industrial and municipal waste [Mahmood et al. \(1992\)](#).

The negative logarithm of a solution's hydrogen ion concentration is called pH which is one of the most crucial elements in the management of water quality, even though it typically has no direct effect on water users [Shrivastva et al. \(1989\)](#). The pH of water may be influenced by a wide range of contaminants, including point and non-point natural sources of water pollutants from residential, commercial, and agricultural activities. Water with a pH of less than 4 has been known to cause eye irritation and redness [WHO \(1999\)](#).

Dissolved oxygen (DO)

The average amount of dissolved oxygen (DO) was 8.8 mg/L, with values ranging from 6.4 mg/L to 10.4 mg/L from sites I, II, and III, respectively. Almost all of the sampling sites in the current study had dissolved oxygen values above the WHO guideline value of 6 mg/L, indicating anthropogenic contamination of the surface water (river) source. Depletion of DO was also brought on by increased microbial breakdown of a significant amount of organic matter at Site 3. The concentration of oxygen is reduced due to heavy organic matter contamination. Under such circumstances, oxygen in the water can occasionally completely disappear [Trivedy & Goel \(1986\)](#). It is among the most crucial elements in determining the quality of the water. The amount of oxygen dissolved in the water is measured by the amount of dissolved oxygen. It gets into water bodies either by air or as a byproduct of aquatic plants. The oxygen content of the water can be high or low. Water that is saturated with oxygen tastes good, while water that is deficient in oxygen tastes bland.

Total alkalinity (TA)

Total alkalinity is the capacity of water to resist acidification. The alkalinity values provide an idea of the nature of salt present in water. It controls the pH of water bodies, which controls the biota's quality. Human health is not harmed by alkalinity per se. For residential use, water supplies with less than 100 mg/L are preferred [Trivedy & Goel \(1986\)](#). Because of the relationship between alkalinity, carbon dioxide, and pH value, alkalinity can exist in water below the neutral point of pH 7.0 [Twort & Crowley \(1985\)](#). The bicarbonate (HCO_3) value ranged from 105mg/L to 125 mg/L from the site I, site II and site III respectively and the average total alkalinity value was 115 mg/L were below the WHO guideline value of 125-350 mg/L. The TDS of river water at Site 3 is increased by more anthropogenic activities, home septic tanks, and the discharge of household waste.

Nitrate (NO_3)

The value of nitrate ranged from 3mg/L to 5mg/L from the site I, site II and the site III respectively and the average nitrate value was 4.33 mg/L. The nitrate values of all samples were below the WHO permissible limit of 50 mg/L. Through the biochemical activities of microorganisms, excessive use of nitrogenous fertilizers, organic manures, human and animal wastes, and industrial effluents contaminate

surface water with inorganic pollutants like nitrate. The contaminated drinking water with excess concentration of nitrate may cause respiratory disease methaemoglobinaemia by absorbance of nitrate in blood which prevents oxygen transport in bottle fed infants upto 4 months [Cecil \(1982\)](#). This is caused by conversion of nitrate to nitrite in the stomach and due to this baby may die Annable (1987).

Nitrite (NO₂)

The value of nitrite ranged from 0.3 mg/L to 0.5 mg/L from the site I, site II and site III respectively and the average nitrite was 0.43 mg/L. Nitrites are an element of the nitrogen cycle that occur naturally and are chemically inert. It has nitrogen in an oxidation state that is comparatively unstable. Microbial action has the ability to decrease it. Through chemical and biological processes, it can further reduce nitrite to various compounds or oxidize it to nitrate [ICAIR Life Systems, Inc. \(1987\)](#).

Ammonium (NH₄)

The value of ammonium ranged from 0mg/L to 0.3mg/L from the site I, site II and site III respectively and the average ammonium was 0.3 mg/L. Since ammonia in drinking water does not immediately pose a health risk, no health-based guidelines have been proposed for it. However, as its concentration level rises and falls, nitrite formation occurs in distribution systems, manganese removal filters malfunction and problems with taste and odor arise. Ammonia (NH₃) is converted to ammonium, a positively charged ion, by the addition of a hydrogen proton. The concentration of dissolved salts in the water, its pH, and temperature all affect how much ammonium is produced. Ammonium concentrations that are high can promote the growth of aquatic plants and algae.

Iron (Fe)

The value of iron ranged from 1mg/L to 1.5mg/L from the site I, site II and site III respectively and the average iron value was 1.16 mg/L. All the iron values of surface water samples were found to be above the WHO guideline value of 0.3 mg/L. Iron is found in most raw waters.

An essential component of human nutrition is iron. Although the element is not hazardous, it is unattractive because excessive amounts of it can have a bitter taste, leave brown stains on clothes, and encourage the growth of iron bacteria, which worsens the quality of the water by creating slimes or offensive odors [Twort & Crowley \(1985\)](#). When large amounts of iron are consumed, the condition known as hemochromatosis occurs, causing iron accumulation to cause tissue damage [WHO \(1991\)](#).

Phosphate (PO₄)

Phosphate was not detected in all the three different sites of water samples. The main structural and nutritional component of biota, phosphorus, is the least abundant and is thought to be the main factor limiting primary production in many freshwater ecosystems [Morris & Fan \(1998\)](#). Through household sewage, agricultural fertilizers, and industrial effluents, it finds its way into water bodies as a pollutant. Since phosphorus is actively absorbed by plants, it is rarely found in fresh water at high concentrations. Before nitrogen becomes limiting, high phosphorus concentrations can be a sign of pollution and cause an algal bloom. Controlling phosphorus levels is necessary for the management of surface water, especially for the supply of drinking water. These levels should also be below the rate at which algae grow [ENPHO \(2002\)](#). Long-term phosphorus consumption is a significant contributor to age-related bone loss [Takeda et al. \(2004\)](#). It is in

abundance in igneous rocks and occurs in the form of 187 different minerals [Golterman \(1975\)](#).

Table 1

Table 1 Water Quality in Triyuga Rive, Udayapur, Nepal (Post-Monsoon, 2020)							
S.N.	Parameters	Units	Post-monsoon (2020)			Average	WHO Guidelines
			Site I	Site II	Site III		
1	Temperature	0°C	18	18	20	18.66	12-25
2	TDS	(mg/L)	104	89	112	101.66	1200
3	pH		7.9	7.6	7.5	7.66	6.5-8.5
4	DO	(mg/L)	10.4	9.6	6.4	8.8	4-6
5	T. alkalinity	(mg/L)	115	105	125	115	125-350
6	Nitrate	(mg/L)	0.75	0.44	0.73	0.35	50
7	Nitrite	(mg/L)	0.5	0.3	0.5	0.43	3
8	Ammonium	(mg/L)	0.3	0	0	0.3	1.5
9	Iron	(mg/L)	1	1	1.5	1.16	0.3
10	Phosphate	(mg/L)	0	0	0	0	1
11	Fecal coliform	MPN	15	15	21	17	0

All the parameters are expressed in mg/L except Temperature (°C), pH.

Figure 2

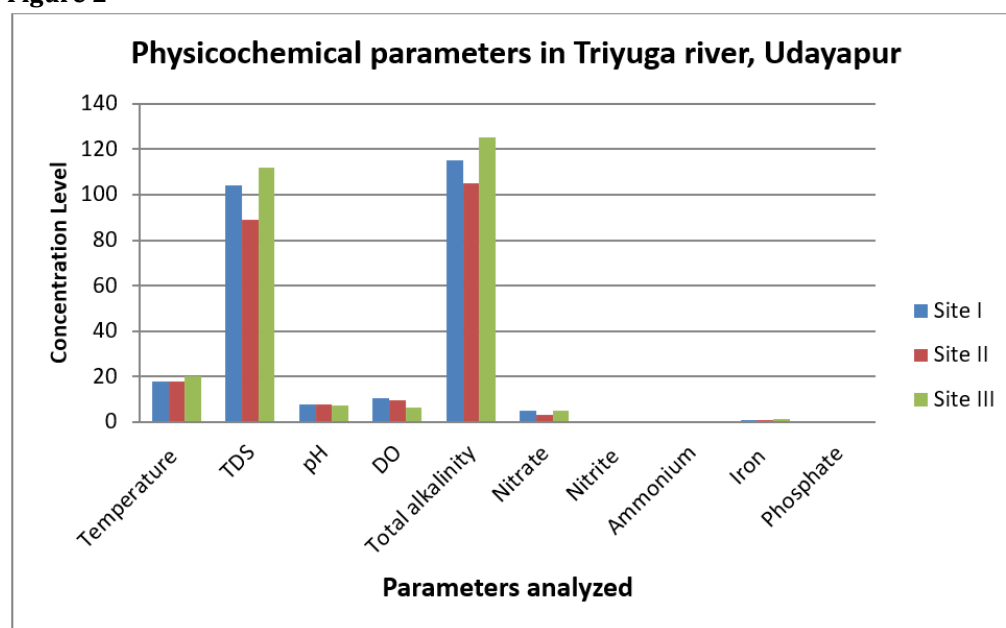


Figure 2 Physiochemical Analysis of Triyuga River, Udayapur, Nepal (2020)

Bacteriological Examination (Fecal coliform)

The value of fecal coliform recorded was 15, 15 and 21 MPN/100ml in Site I, II and III respectively. Surface water microbial pollution can be identified by changes in the abundance of bacterial pollution [Kavka & Poetsch \(2002\)](#). According to [Baghel et al. \(2005\)](#), the presence of bacteria in surface water not only suggests that the water is contaminated with feces, but also raises possible health risks for humans. High indicator bacterial loads are also linked to higher temperatures [Isobe et al. \(2004\)](#). *Escherichia* is the genus of bacteria that cause feces, with occasional strains of *Enterobacter*, *Citrobacter*, and *Klebsiella* also contributing to the population. Only

E. Coli is specifically related to fecal pollution among these organisms [WHO \(1991\)](#). Non-fecal coliforms are slightly more common in animal and human feces than fecal coliforms. Non-fecal coliforms are only recognized as the presumed indicator of fecal contamination because they can also be found in soil and vegetation.

4. CONCLUSION

At Belaka, water of Triyuga River is mainly used for domestic and irrigation purposes and some of them used for drinking purposes also in rural areas. The direct discharge of effluent from home septic tanks, vegetable markets, and household garbage, among other anthropogenic activities, is contaminating the water in this river by combining organic and inorganic contaminants. The quality of drinking water is eventually compromised by these contaminants. Thus, water from this river becomes unsuitable for drinking and other domestic purposes.

Based on the findings of the physiochemical and coliform variables of the surface water (river), it has been determined that the Triyuga River at the study site is contaminated with fecal and household waste materials. The river water that sustains the pollution's nature contains fecal coliform. From a microbiological perspective, water from the studied area should not be used for drinking or household purposes; instead, it should be boiled to eliminate bacteria before being used for any other purpose. The temperature and pH values of three different sites were within the permissible limit of WHO guideline. TDS, Nitrate, Nitrite, Ammonium and Total alkalinity values from all three different sites were below the WHO guideline value. Dissolved oxygen and iron values from all three different sites were above the WHO guideline value.

The results of the current study showed that the river water quality is somewhat contaminated, and they recommend that the necessary precautions be taken to keep these water sources clean. Therefore, the river water can be used for irrigation with precaution, and it is in need for any form of treatment to be used for domestic purposes. Though the present study, was aimed to generate baseline data on surface water quality of study area in Nepal, it needs further detailed investigations, monitoring and treatment to keep the surface water sources of Triyuga River safe for drinking and domestic uses.

CONFLICT OF INTERESTS

None.

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