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Assessing of Physicochemical Parameters and Seasonal Variations in the Tinau River of Palpa, Nepal

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Abstract

The water quality and quantity parameters in lakes, rivers, marshes and lagoons are affected from both natural factors and human activities. The present study was undertaken to assess the quality of water samples with special reference to physicochemical properties of Tinau River. The water samples were collected from November 2021 to September, 2022 and analysed 17 physico-chemical parameters (Temperature, P^H, dissolved oxygen, free CO_2, total alkalinity, hardness, turbidity, Ammonia, Nitrogen, Chlorine, Chromium, Copper, Cyanide, Iron , Nitrate nitrogen, Phosphorus, Silica and Sulphide). The result physic-chemical parameters show that turbidity of water is with slightly basic property with P^H 8, temperature between16-17^{0}C, DO (9-10.1mg/L), Total alkalinity (65-98mg/l), Hardness(4.8-10.5mg/l), Free CO_2(3-4), Ammonia nitrate trace and other components are negative. This showed that research area are good to excellent quality water for different purposes. In addition, for the purpose of maintaining water quality, it is essential to understand specifics about many physico-chemical properties. These factors need additional study because they can induce water poisoning or chronic poisoning in aquatic animals.

Key words: *Chemical parameters; Minerals, Physical parameters, Water pollution, Water quality index,*

Introduction

Water resources are crucial for the survival of all living beings as well as human societies. Water an essential component for life which contains minerals extremely important in human nutrition (Versari et. al., 2002). All freshwater bodies are interconnected to the oceans, the atmosphere, and aquifers via a complex hydrological cycle. Water quality comprises all physical, chemical and biological factors of water that affect the uses of the water (Alley, 2007). The increased demand for water as a consequence of population growth, agriculture and industrial development has taken environmentalists to determine the chemical, physical and biological characteristics of natural water resources (Sawant & Telave, 2009). Sources of fresh water (Lakes and ponds) are fundamental importance to man. However pond may have been natural water sources exploited by man at different time to meet different needs or may have been created for a multitude of different purposes (Rajagopal *et al*., 2010). Fresh water of rivers and lakes, brackish water of marshes and lagoons and salt water of coastal areas are affected from both natural processes and human activities. Water quality can have a major impact on both individuals and communities health. Due to the usage of contaminated drinking water, the human population suffer from a number of water-borne diseases, so it is essential that the quality of drinking water be tested on a regular basis (Patil *et al*., 2012). Water quality models are often implemented in order to quantify biological, physical, and chemical transformation of constituents of interest and to investigate the impact of altered boundary conditions on aquatic ecosystems (Wagenschein & Rode, 2008). The water quality and quantity parameters in lakes, rivers, marshes and lagoons are factors of great importance (Margoni & Psiovikos 2010). Water quality degradation and surface water contamination are mostly caused by anthropogenic sources, such as untreated industrial wastes, inadequately disposed of household garbage and agricultural run-off (Rahman *et al*., 2021).

Physical parameters include colour, odor, temperature, transparency, turbidity, total solid wastes etc. Chemical characteristics involve parameters such as pH, dissolved oxygen (DO), free CO2, alkalinity, total hardness, presence of ammonia, phosphate, chlorine, calcium, magnesium etc. Likewise, biological indicators of water quality include fishes, macrophytes and phytoplankton (Thapa, 2022). Hydrological condition of river water affects the aquaculture activities, decrease in fish productivity and change in species and overall loss of biodiversity which resulted in the degradation of pond ecosystem (Sinha, 1995). The excessive concentrations of pollutants present in many rivers raise the biological need for oxygen on a chemical and biological level (Achi, 2011).

A close monitoring of water quality, physical, chemical, biological is needed from time to time to maintain its standards (Sharma, 1997). Compared to temperature and conductivity, the P^H of the water changed significantly less. Since the characteristics of the water, particularly temperature, are important regulators of biological life that develops in water, the alterations in the river may have reduced the habitat conditions for fish and other aquatic species (Soja & Wiejaczka, 2013).

Tinauis fresh water river origin from Palpa district, run through various mountain base and flow in low land of Rupandehi district. Near to the river, has variety of habitats. Fertilizer, washing soap, bi-product of organism, and human activities reduced the quality of water. The quality of the water source gradually degrades as a result of development activities, changes in the climate, and hydrological and hydrologic factors (Shan, 2011). Physicochemical parameters like P^H, dissolved oxygen, free CO_2, total alkalinity, hardness at various dissolve inorganic ions maintain the water quality. These parameters were important for aquatic life, drinking purpose and irrigation. Several Physicochemical or biological factors could act as stressors and adversely affect fish growth and reproduction (Iwama *et al*., 2000). In rainy season erosion of soil and mixing with water produce the physical pollutions. The physico-chemical parameter of Tinau river has undergone many changes due to variation in climatic condition and anthropogenic pressures. Seasonal effects, use of pesticides in agricultural lands and mixing of toxin for killing fishes may changes the physic-chemical parameters. So the present study was undertaken to assess the quality of water samples with special reference to physicochemical properties of Tinau River.It also provide the seasonal effect on quality of water. It will help to develop the knowledge and its effect to the people, responsibility to society, and preventive measures for water pollution. This study expands the knowledge of previous research.

Methods and Materials

Study area

There are 4 sampling stations have been chosen for present study area**.** The location of the samples collecting spots around the study area are shown in Fig. 1.

a) **Sampling Stations :** Latitude and Longitude of the sample collecting spots were recorded with the help of GPS reading.

1. Near Pravas pond (A): This area lies near the wetland. The stream is small. Agricultural land lies near this area and also small human settlement area.
2. Dumre station (B): This area lies near the small town and Dumre river meet to this stream. The main human activities at this site were washing, bathing and fishing.
3. Base of Charchare village(C): It is the forest area where Tinau river meet.
4. Near Jhumsa Bridge (D): Many small river meet to this river and small human settlement area.

b) **Method of Data Collection :** The water samples were collected from surface water from different stations. The study mainly based on the primary data that is the result obtained from the collection, experiment, and observation.

c) **Sampling Technique :** There are four main site (A, B, C, and D) was taken for water sample collection. These areas are near the agricultural fields (site A) human settlement area (site B), forest area (site C) and near the junction of two rivers (site D). The colour and visibility of water is observed directly. Electrical instruments like P^H meter, and Temperature meter were used in sampling station in field. The temperature, turbidity and

P^H are observed by electrochemical device and Secchi disc. Samples were taken in BOD bottles and fixed with alkaline standard solution of $KMnO_4$ and other water samples were collected in plastic bottles for lab for experiments in the laboratory of Tribhuvan Multiple Campus, Palpa. The physico-chemical parameters such as total alkalinity, total hardness and dissolved oxygen were analyzed by titration method. Ammonia nitrogen, Chlorine, Chromium, Copper, Cyanide, Iron, Nitrate nitrogen, Phosphorus, Silica, Sulphide and analysis were carried out by using kit; LAB-AIDS*#19. The interviews were also taken by visiting local people. Mainly descriptive analytical method were applied for sample design.

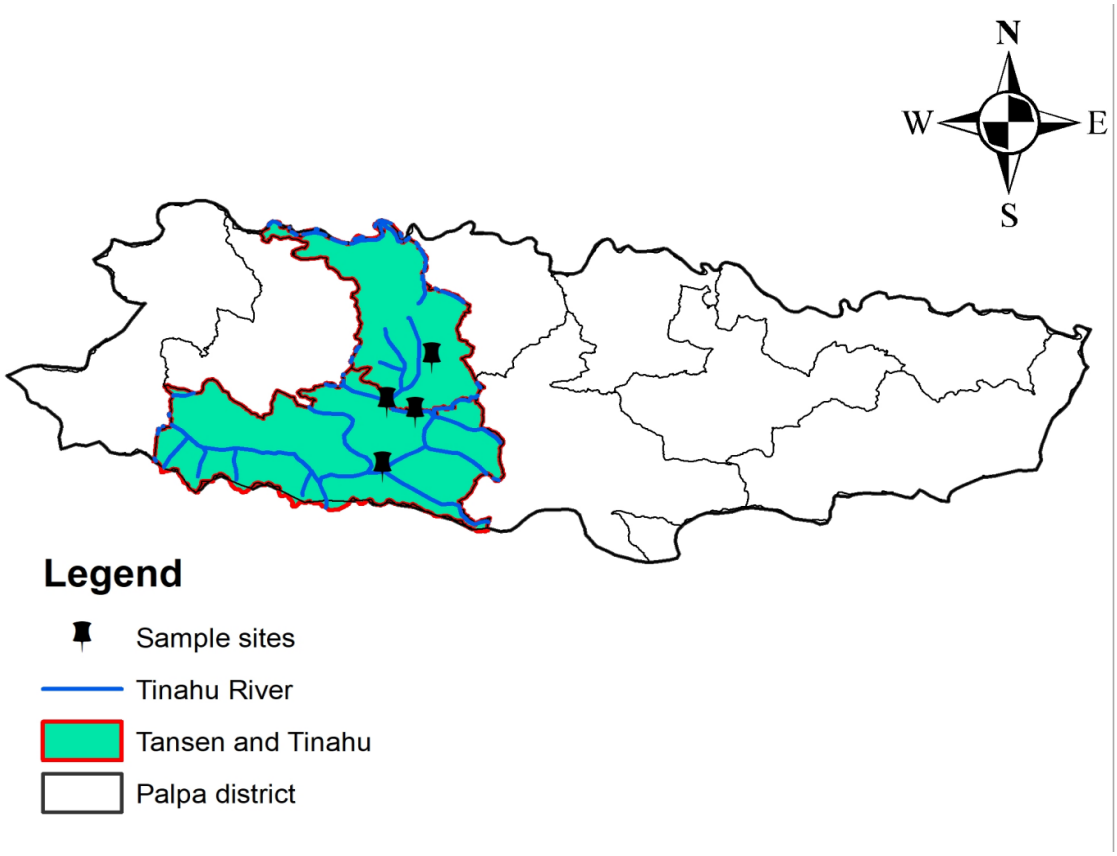

Figure 1. Map of Tinau river in Palpa district

d) Data analysis, interpretation and presentation : Turbidity of water were measured by using Secchi disc. It measured the transparency of water.

$$\text{Transparency (D)} = \frac{\text{Just disappearance} + \text{Just reapparance}}{2}$$

Oxygen slightly dissolved in water which is essential for aquatic life. It dissolved in water by photosynthesis and directly dissolved from environment.

$$\text{Dissolved oxygen (DO)} = \frac{\text{Vol} \times \text{N of titrant} \times 8 \times 1000}{\text{V2 (V1} - \text{V)/V}} \text{ mg/L}$$

V= volume of $MnSO_4$ and KI

V_1= volume of water sample of BOD bottle

$V_{2=}$ volume of part of content titrate

Dissolve Mg and Ca ions in water produced alkalinity of water.

$$\text{Total Alkalinity (Ta)} = \frac{B \times N \text{ of HCl} \times 50 \times 1000}{\text{Vol of water sample}}$$

B= Volume of total HCl used with Phenolphthalein and Methyl orange

$$\text{Hardness of water (HD)} = \frac{\text{Volume of EDTA} \times 1000}{\text{Volume of water sample}}$$

The experimental and observed results were tabulated, analyzed and interpreted. Mainly descriptive analytical method were applied for the analysis of data.

Results and Discussion

Table 1: Physic-chemical parameters of different station of Tinau river at winter season

Ser. No	Parameters	Stations and means				Remark
		A	B	C	D	
1	Temperature ^{0}c	16^0c	16^0c	17^0c	17^0c	
2	Turbidity	Clear	Clear	Clear	Clear	
3	P^H	7.8	7.6	8	8	
4	DO (mg/L)	9.28	9.0	10.2	10.01	
5	Free CO_2	4.0	3.0	3.2	3.2	
6	Total Alkalinity (mg/L)	37.5	39.25	32.2	30.5	
7	Hardness (mg/L)	6.8	10.5	8.8	8.8	
8	Ammonia nitrogen	Trace (+)	Trace (+)	Trace (+)	Trace (+)	
9	Chlorine	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
10	Chromium	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
11	Copper	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
12	Cyanide	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
13	Iron	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
14	Nitrate nitrogen	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
15	Phosphorus	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
16	Silica	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
17	Sulphide	Neg (-)	Neg (-)	Neg (-)	Neg (-)	

Table 2: Physic-chemical parameters of different station of Tinau river at rainy season

Ser. No	Parameter	Stations and means				Remark
		A	B	C	D	
1	Temperature^{0}c	21^0c	26^0c	27^0c	23^0c	
2	Turbidity	Muddy	Muddy	Muddy	Muddy	
3	P^H	7.5	7.9	7.5	7.6	

4	DO (mg/L)	8.28	8.5	9.0	8.9	
5	Free CO_2	4.5	4.2	3.5	3.5	
6	Total Alkalinity (mg/L)	30.5	33.0	31.5	31.6	
7	Hardness (mg/L)	7.8	9.5	9.1	8.8	
8	Ammonia nitrogen	Trace (+)	Neg (-)	Neg (-)	Neg (-)	
9	Chlorine	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
10	Chromium	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
11	Copper	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
12	Cyanide	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
13	Iron	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
14	Nitrate nitrogen	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
15	Phosphorus	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
16	Silica	Neg (-)	Neg (-)	Neg (-)	Neg (-)	
17	Sulphide	Neg (-)	Neg (-)	Neg (-)	Neg (-)	

The seasonal variation of physio-chemical characteristics of Tinau River at four sites have been summarized in Tables (1-2). Saravanakumar and Ranjith (2011) noted that the physicochemical parameters showed a small degree of variation. The temperature is taken at day so it varies according to altitudinal variation i.e. inverse to altitude. Temperature plays a very important role for metabolic and physiological activities of the organism. In the present study the average value of water temperature varied from 16^0c to 27^0c.The average temperature increase by decreasing altitudes. The average temperature was seems to increasing than that was recorded by Sharma *et al.* (2003). The lower temperature during winter season is due to atmospheric temperature and duration of sunlight (Kundangar *et al*., 1996).

The transparency is clear at various stations but turbid during rainy seasons. Due to the entry of silt during heavy rainfall from the adjoining fields and nearby hills sides and human and agricultural activities causes the turbidity during rainy season.

The P^H was slightly alkaline about 7.5 to 8 and slightly different between seasons. According to APHA (1992), P^H values of natural water usually has P^H value 7.0 but sudden changes showed water pollution. This results meet the standard of WHO. This values were higher winter than rainy season. A similar result was obtained by Sharma *et al*. (2003) and Jha *et al*. (2007) in this river. The P^H values lower than the 6.5 (acidic) and greater than 8.5 (alkaline) were not suitable for human consumption or drinking purpose (Howladar *et al.,* 2018). But in present study, the P^H values indicated that this water quality was good for drinking purpose. The P^H of water is closely related to the carbon dioxide content. In aquatic ecosystem, the P^H of water is a function of the dissolved carbon dioxide content, which in the variation of the total alkalinity was decreasing order due to growth of plants in the study period.

Dissolved Oxygen was at the highest value (10.2 mg/L) and lowest 8.28 mg/L. The higher concentrations of dissolved oxygen during winter season was probably due to low water temperature, no turbidity and increased photosynthetic activity of the green algae found on the

submerged stones and gravels. Poudel *et al*. (2013); Pandey and Devkota (2016) reported similar result in winter season however Hannan *et al.* (1978) reported the similar result in rainy season also. It is due to the circulation and mixing by inflow after rain. The amount of dissolved oxygen is influenced by turbulence, temperature, salinity, photosynthetic activity of plants and algae, and atmospheric conditions (Sallam & Elsayed, 2018). The level of dissolved oxygen in water decreases with increase salinity and temperature.

Total alkalinity ranges from 30.5 mg/L at station A to 33.0 at station B rainy season and ranges from 30.5 to 39.25 mg/L at winter season. The suggested alkalinity for drinking water is 20–200 mg/L (WHO, 2011). It is attributed to bicarbonates, carbonates, OH ions, borates, silicates and phosphates (Kataria *et al*., 2006). The present study exhibited the definite pattern of total alkalinity seasonally. Human activities were high in station B so that it has high alkalinity. Total alkalinity has been variously termed as alkalinity, alkaline reservoirs or acid binding capacity. Usually the total alkalinity shows inverse relation with carbon dioxide content in water. This values were slightly higher in winter season. Similar result were reported by Pandey and Devkota (2016). The total alkalinity of water is mainly due to the total cations or carbonate ions of calcium, magnesium, sodium, potassium, ammonium, and iron combined as carbonates or bicarbonates or occasionally as hydroxide. Usually the total alkalinity shows inverse relation with carbon dioxide content in water. During the present study the average value of hardness was found in between 6.8 to 10.5 mg/L. All these above parameters were lied within limit. So that this river provided the good aquatic environment for aquatic life.

Ammonium nitrogen, Chlorine, Chromium, Copper, Cyanide, Iron, Nitrate nitrogen, Phosphorus, Silica and Sulphide are the major pollutant in water but these components are absent during analysis. According to the WHO (2011) suggested that these inorganic ions were must include in surface water for drinking. These dissolved materials were through water directly by aquatic flora, which help to reduce some amount of certain water pollutants so that Tinau river is less polluted.

Conclusion

The water quality around the Tinau River have been evaluated seasonal characteristics regarding the identification of the dominating sources of different water quality parameters. The seasonal variations of parameters have been significantly high during winter season in station B and less in station D in rainy season. The dense vegetation cover and less populated area in the station Charchare and Jhumsa area has good quality of water. All the physicochemical parameters are within the standard limit of WHO except ions of various metals and non metals. Dissolves of ions in natural fresh running water are major pollutants so that this river is less polluted.

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