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Research Article

EVALUATION OF PROMINENT PARAMETERS OF HYDROCHEMISTRY OF BEGNAS LAKE

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Abstract

This study has been conducted to measure the water quality of Begnas Lake, Pokhara, Nepal. After the collection of different samples from the lake, variety of physico-chemical parameters like hydrogen ion concentration (pH), total hardness (TH), total solid (TS), total dissolved solid (TDS), total alkalinity (TA), calcium (Ca^{2+}), magnesium(Mg^{2+}), Potassium (K^{+}), chloride ion (Cl^{-}), phosphate (PO_4^{3-}), sulphate(SO_4^{-2}), Nitrate (NO_3^{-}), ammonium (NH_4^{+})and iron (Fe^{2+}/Fe^{3+}) have been studied in laboratory whereas transparency, temperature, dissolved oxygen(DO) have been noted on the spot. In addition to this, microbial contamination in this lake has been studied in microbiology laboratory to study the presence of *coliform* bacteria by adopting MPN method. This water contains greater concentration of iron and alkaline earth metal ions along with low oxygen content and high ammonium and carbon dioxide concentration indicating severe rock weathering, open dumping of solid waste, industrial and agricultural effluents in lake water. Various natural and anthropogenic factors have been causing rapid eutrophication and water quality degradation in the lake.

Keywords: Hydro-chemical parameters, livelihoods, eutrophication, microbial contamination, effluents,ecological balance.

INTRODUCTION

In Nepal, about 3950 sq.km and 3500 sq.km area is covered by Lotic and Lentic environment respectively. Nepal consists of 5000 lakes whose area is less than one hectare, among them ten are listed in Ramsar site (Bhuju *et al.,* 2009). Pokhara valley has several lakes like Fewa, Begnas, Rupa, Khaste, Maidi, Deepang, Gunde, Neureni and Kamalpokhari. Among them, Begnaslakeis the second largest lake after Phewalake of Pokhara Metropolitan City. Begnaslake is announced as Ramsar site from Nepal on 2nd February 2016, with surface area 3.28 sq.km at an altitude of 650 m. It is a multipurpose freshwater lake with water volume 17.96×106 m^3 (Khadka *et al.,* 2013) used for irrigation, commercial fish production, recreation, and other livelihood related activities. Water is not only the essential material resource for the human civilization but also an important basis for sustainable development of the country. The anthropogenic activities and their side effects are very intense on quantity and quality of lake waters. The better quality of water in lake is extremely important for maintaining different types of recreational activities, for fish farming and for supplying the qualitative drinking water to the livelihood (Pant *et al.,* 2018). In context of our country Nepal, local livelihoods are strongly related with the wetland resources for their existence and economic wellbeing. The main purpose of this lake water is for irrigation and even some parts of the lake are used as caged fisheries. The wet catchment areas around it have been and are still being converted to paddy fields gradually. The major factor that causes the threat on the lake water are intense urbanization, agricultural and domestic dismissal, siltation, and heavy metals. These components cause gradual gathering of different types of water born pollutants. Moreover, it has caused the numeric pathogenic bacterial microorganism which may show negative effect on its exposure directly or indirectly via any source (Neupane *et al.,* 2010). Mackay, (2008) has recognized that the water with its quality and availability would become the major issues in societies and environment under the changing scenarios of global climate. The water quality is directly related to the human health and thus it is one of the major concerns of people. The stability and sustainability of an aquatic ecosystem for supporting life forms also depends on the various characteristics of water. Some of the considerable physicochemical parameters of water are temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), total alkalinity (TA), total hardness (TH), calcium (Ca^{++}) magnesium (Mg^{++}), potassium (K^{+}), chloride (Cl^{+}), nitrate (NO_3^{--}), sodium (Na^{+}), sulphate (SO_4^{2-}) and phosphate (PO_4^{3-}) etc.(De, 2003)These parameters should be tested in order to assess the quality and purity water for drinking and other purposes. The investigation conducted by (Pant *et al.,* 2019)for analyzing physiological characterization of water of Begnas lake indicates major concerns with phosphate ion, 0.07-0.13 mg/L (WHO, 0.02) and free carbon dioxide (CO_2) with 11-14.7 mg/L (WHO,< 10). The elements like phosphorous and nitrogen, perform primary role for the progressive development of aquatic life and algae in lake water, are usually appear in the forms such as PO_4^{3-}, NO_3^{-}, and NH_4^{+} etc. The chemicals from the raw or treated sewage, agriculture and household drainage and certain industrial wastes etc. are the direct suppliers in the lake and also played vital role in maintaining the aquatic life in the natural waters.

The worst situation is that these water resources are used for the drinking purposes in places. The main reason for the microbial contamination in Nepal is found to be agriculture runoff along with direct sewage dumping and leakage of sewerage in the water resources (Gautam *et al.,* 2008).

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Table 1. WHO Guidelines of some Physico-chemical Parameters of Drinking Water

Physico-chemical Parameters	Guideline Value	Physico-chemical Parameters	Guideline Value
pH	6.5-8.5	Magnesium	50
Dissolved Oxygen	5	Potassium	20
Total dissolved solid	500	Ammonium	0.3
Total Hardness	500	Iron	0.3
Total Alkalinity	600	Phosphate	0.02
Chloride	250	Nitrate	10
Calcium	100	Sulphate	250

(All the unit in mg/L except pH)

Source: WHO, 2011

MATERIALS AND METHODS

The Begnas Lake is considered as the second largest lake situated in Pokhara Valley covering the total area of 20km^2. It is situated in between the Greater Himalaya and the Mahabarat range at altitude of 637m above sea level (28^{0}09'-28^{0}13'N-84^{0}04'-84^{0}07'E). The maximum depth of the lake is 10m. The main source of lake is Syankhudi Khola and the water is drained out by KhudiKhola from the western part.

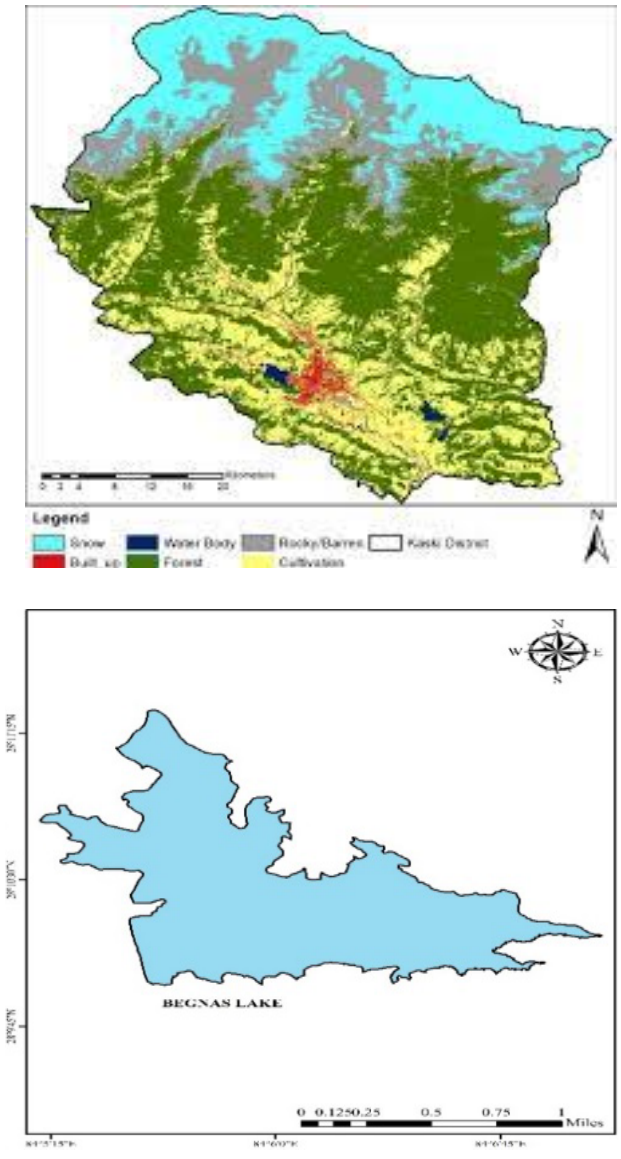

Figure 1. Location and shape of BegnasLake

Study Area

Ten samples were collected within the range of 80-100m from each spot. The samples were collected in the middle of November 2021 and were examined for obtaining Physico-chemical parameter of water. The physico-chemical parameters of the collected water samples were examined as per the standard procedure in laboratory as well on the spot.

Table 2. Methods applied for assessing the Physico-chemical Parameters

Parameters	Methods employed
Transparency (cm)	Secchi disc method
Temperature (◦C)	Standard mercury thermometer
Dissolved Oxygen (mg/L)	Winkler's iodometric titration Method
Hydrogen Ion Concentration	Microprocessor pH meter
Total Alkalinity (mg/L)	Titration Method
Total hardness (mg/L)	EDTA Titration Method
Total Solid (mg/L)	Evaporation Method
Total dissolved Solid (mg/L)	Filtration Method
Calcium (mg/L)	Titration Method
Magnesium (mg/L)	Titration Method
Chloride (mg/L)	Titration Method

Some of other parameters such as Sulphate, Phosphate (PO_4^{3-}), Nitrate(NO_3^-), Ammonium(NH_4^+), Iron(Fe^{2+}/Fe^{3+}) were studied with the help of spectrophotometer(Thangiah, 2019). The concentration of Potassium(K^+) was estimated by Flame Photometer and electrical conductivity by conductivity meter. In addition to this, the microbial contamination in the lake was analyzed by Most Probable Number (MPN) method.

RESULTS AND DISCUSSION

The physico-chemical parameters measured are critically analyzed and then compared with WHO guideline value. During the study period, the temperature of lake water ranged from 24ºC to 30ºC. Transparency is a measure that calculates the depth of water up to which light penetrates. It is found to be 87cm which is less than WHO value of 100cm indicating the lake water to be polluted enough. Generally, water with increase temperature favors the survival of green phytoplankton, weeds and other water organisms (DK *et al.,* 2003).Declination of water quality takes place on increasing temperature due to reactivity of various substances contained with water. The pH of lake water is 7.1 making it slightly alkaline. This alkalinity may be due to high organic pollution and carbonate weathering. The EC values of the sampling lake water are found to be 43µScm^{-1} which is a little bit higher than guideline value of WHO. Electrical conductance is caused by the presence of various soluble salts contained in water.The total solid in Begnas Lake is140 mg/L that may be due to the presence of plenty of suspended particulates. On the other hand total dissolved solid which is the sum of all the organic and inorganic matters induced by natural and anthropogenic activities in liquid, is measured to be52mg/L in average. This higher level of TDS has negative effects on human health and ecological paradigm. The occurrence of ions of carbonates, bicarbonates, and hydroxide in the water is the reasons behind its alkalinity. Major source of these substances may be carbonate rocks like limestone, dolomites, magnesite, etc. Total alkalinity of the water is 56mg/L. The dissolved oxygen (DO) observed in the Begnas lake is found to be 4.1mg/L which is slightly above the minimal permitted guideline suggested by WHO (5 mg/L).

Table 3. Physicochemical characteristics of Begnaslake obtained from water quality assessment.

Parameters	Mean value	WHO value (2016)	Parameters	Mean value	WHO value (2016)
Transparency	87.0	100.0	Chloride	16.5	20.0
Temperature	30.0	12-25	Calcium	35.0	10.0
pH	7.1	6.5-8.5	Magnesium	15.0	5.0
EC	43.05	40.0	Potassium	2.5	2.0
TS	140.0	120	Ammonium	1.5	1.5
TDS	52	45.0	Iron	0.9	0.3
DO	4.1	5.0	Phosphate	0.03	0.02
Total hardness	136.0	50.0	Nitrate	0.59	0.50
Alkalinity	56.0	100.0	Sulphate	2.6	2.50
Free CO_2	3.2	1.5			

(All units in mgL^{-1}, EC in $\mu S\ cm^{-1}$, Transparency in cm, Temperature ◦C)

According to WHO, the concentration of DO below 5 mg/L is insufficient for aquatic life. Similarly, total hardness (TH) of water is the measure of magnesium and calcium salts present in water. It is measured 136mg/L which is considerably higher as compared to WHO standards of 50mg/L. The concentration of Mg^{2+} and Ca^{2+} in this lake water is found to be 15mg/L and 35mg/L which are within the value as mentioned by WHO, 5mg/L and 10mg/L respectively. This excessive concentration of alkaline metal ions may be accounted by the presence of their salts across the catchment areas that enable these ions to drain in lake water during weathering. Consumption of this water may sow adverse effect on our health causing high blood pressure, breakage of nerves and avoiding flow of blood in brain, deposition of chemical causing stones in urinary bladder, and shortness in breathing. The chloride content in the Begnaslake was found to be 16.5mg/L in average which is closer to the WHO standards of 20mg/L. The major source of chloride in lakes and ponds are deposition of animal excreta and domestic run off and may be due to presence of mica, apatite minerals and from the emission of chloride insertion in liquid form through the igneous rocks, including some other signatures by human activities. Chloride concentration above permissible level causes unpleasant taste in association with diverse physiological disorders. The potassium concentration in this lake is documented to be 2.5 mg/L, a little bit higher than standards, makes this water unacceptable for drinking purposes. The macronutrient which favors the growth and development of aquatic plants, microorganism and algae are phosphorous and nitrogen, which are present in the forms of PO_4^{3-} , NO_3^-, and NH_4^+in lake water. Raw or treated domestic, agricultural, and sewage and runoff from factories are the major sources for the addition of these nutrients in the lake. Besides these, anthropogenic activities, other possible sources for nitrate content may be accumulation of nitrogen from atmosphere and minerals, and sedimentation of compounds containing nitrogen. Nitrate, ammonia and phosphate are present in higher concentration in this water indicating the rapid influence of eutrophication around the territory of lake. The sulphate concentration of the water is also higher to standards. Iron is a heavy metal which may exist in two forms one soluble ferrous form and another insoluble ferric form in water. In the present study iron concentration in lake water is0.9mg/Land is higher than WHO standard value of 0.3mg/L. Iron bearing soil and rock attribute higher concentration of iron. Thermodynamically, in a natural water bodies and reservoirs, iron(II) is normally oxidized to iron(III). Iron containing water may be rusty red or brown color that may causemultiple health hazards in human and other organism. Water quality is also determined with CO_2concentration as it makes water acidic and decreases dissolved oxygen and biological oxygen demand making water unsuitable for consumption by living beings.

Begnas lake is contaminated with an excess concentration of CO_2 measuring 3.2mg/L. Most probable number (MPN) method was adopted to investigate the microbes in sampled lake water. The microbial analysis of water sample suggests that this lake water contains coliform but was not fecal in origin(Rice, et. al.,2012). The presence of coliform indicates that there might be a presence of other enteric pathogen which makes water not suitable for consumption.

Conclusion

The physico-chemical parameters of Water of Begnaslake measured have been analyzed critically and compared with WHO standards and lake water is evaluated as mildly polluted for consumption by human and other animals. Almost all of the parameters exceed accepted standards. Discharge of household and agricultural effluents are mainly responsible for increasing the nitrate and phosphate concentration which favour the growth of hydrophytes in the Lake. Excess concentration of the iron in Lake water, 0.9mg/L may be due to the soil erosion, landslides, and weathering of iron containing rocks in lake which consequently degrade the quality of water. The analysis of all the hydro-chemical features of Begnaslake indicates that the lake water is mildly polluted to support the aquatic life. Rapid eutrophication due to anthropogenic activities like fast growth of urban and industrial areas leads to the release of domestic, agriculture, solid waste and industrial byproducts which would be the major threat towards the lake and watershed. Effective monitoring and mitigation programs throughout the lake should be performed by all the concerned peoples and authorities for sustaining the ecological balance in the lake territory.

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