Prithvi Journal of Research and Innovation
[A Peer-Reviewed, Open Access Multidisciplinary Bilingual Journal; Indexed in NepJOL]
ISSN 2705-4888 [Print]; ISSN 2705-4896 [Online]; JPPS Star-Rated Journal
Volume 3; 15 December 2021; pp. 9-17
eJournal Site: http://ejournals.pncampus.edu.np/ejournals/pjri/

---------- *ORIGINAL RESEARCH ARTICLE*

The Status of Abiotic Components in Aquatic Environment of Khaste Lake, Pokhara

Raju Kumar Poudel
Department of Chemistry, Prithvi Narayan Campus, Pokhara

Article History:
Submitted 10 October 2021
Reviewed 17 November 2021
Accepted 13 December 2021

Corresponding Author:
Raju Kumar Poudel
Email: poudelraju100@gmail.com

Article DOI:
https://doi.org/10.3126/pjri.v3i1.41626

Publisher:
Centre for Research and Innovation
Prithvi Narayan Campus
Tribhuvan University
Pokhara, Nepal
[Accredited by UGC, Nepal]

Tel.: +977-61-576837
Email: research@pncampus.edu.np
URL: www.pncampus.edu.np

ABSTRACT

Water is one of the most significant natural resources. In plants and animals, different physiological processes like respiration, photosynthesis, absorption of nutrients and other metabolic process get influenced by the amount of availability of water. This study has been conducted to evaluate water quality of Khaste Lake, Pokhara. After the collection of water samples, chemical parameters such as dissolved oxygen (DO), free carbon dioxide (F-CO_2), hydrogen ion concentration (pH), total alkalinity (TA), total hardness (TH), total solid (TS), total dissolved solid (TDS), calcium (Ca), magnesium (Mg) and chloride ions (Cl^-) have been measured in the chemistry laboratory, using standard methods prescribed by American Public Health Association (APHA, 1999) whereas the depth, transparency and temperature have been measured on the spot. The obtained values of physico-chemical parameters have been compared with the criteria of World Health Organization (WHO) and other lakes. The research reveals that all the abiotic components of the Khaste Lake meet the WHO standard of water quality. This research work concludes that the water quality of Khaste Lake is much less polluted and suitable for all the aquatic lives so far. Discharge of domestic sewage, use of fertilizers and pesticides in agriculture fields and other solid waste dumps can be the major threats for sustainability of the lakes. Awareness to the public and continual management need to be done to prevent the possibility of pollution and eutrophication process.

KEYWORDS: Abiotic, total alkalinity, total dissolved solid, dissolved oxygen, Khaste Lake

INTRODUCTION

Water is vital, widely distributed and a useful natural resource on the earth for living beings. It covers three quarters of the earth's surfaces. Rivers, rain water, water from melting ice, hail water, stream, reservoirs, ground water and shallow well are different sources of water on the earth. Due to continuous evaporation and cooling process in atmosphere, various forms of water keep changing, a process called water cycle. The water cycle is important for the entire living beings. Aquatic environment is divided into two parts: 1) Marine environment contains 3.5 % salt and 2) Fresh water environment contain 0.001%-0.05 % salt (Pennak, 1953). Three percent of the total water on the earth is fresh water and ninety-seven percent is salt water in the oceans (Bastola et al., 2010). The fresh water environment is categorized into two divisions: 1) Lotic environment also called running water bodies like rivers, streams, springs, etc. and 2) Lentic environment also called still water or standing water bodies like lakes, ponds, swamps, bogs, reservoir, etc. The estimated area of all the lakes is about 1.4% of the world's total land area and the total volume of the lakes exceeds 176,000 km^3 (UNESCO, 1978); Some 40% of the total volume of fresh water is contained in the great lake basin.

Out of 1.36 billion cubic kilometer of earth's water, 37.5 million cubic kilometers water is fresh water (Subramanyan, 1986). About three percent of the total land area is covered by wetlands (Noble & Wolf, 1984). Lotic environment covers an area of about 3950 sq.km. and lentic environment an area of about 3500 sq.km in Nepal (FDD, 1992). There are more than 5000 lakes in Nepal having an area of less than one hectare and out of them, ten are listed in the list of Ramsar site (DNPWC, 2016). The water sources of Nepal consist of many rivers, streams, lakes, reservoirs, ponds and swampy land, which cover about 4063.80 sq.km of total area of Nepal (RONAST, 2002). The lake water is directly used by human beings for drinking, bathing, washing, irrigation, fish farming and general hydro-electric power. Pokhara Valley is famous for its lakes, and considered the city of nine lakes. Fewa, Begnas, Rupa, Khaste, Maidi, Deepang, Gunde, Neureni and Kamalpokhari are the major lakes of Pokhara. This study was conducted to evaluate the abiotic components of Khaste Lake. This lake is the fourth largest lake of Pokhara Metropolitan City. The physico-chemical parameters like depth, transparency, temperature, dissolved oxygen, free carbon dioxide, hydrogen ion concentration, total alkalinity, total hardness, total solid, total dissolved solid, calcium, magnesium and chloride ion are non-living or abiotic components of the lake system. This research was conducted to examine the present status of abiotic components of the Khaste Lake. This research is supposed to be a guideline for new researchers and a reference for the continual management of the water quality.

MATERIALS AND METHODS

Study Area

Khaste Lake (Figure 1) is situated at the Kharane Phant of Pokhara Metropolitan City, Ward No. 26, about 2.5 km from the Prithvi Highway. It is situated in between 28.1937^0-28.1944^0 latitudes and 84.0481^0–84.0535^0 longitudes (http://nationalgeoportal.gov.np/cadastral/). It covers an area of 0.24803 sq.km out of which 0.13737 sq.km area is covered by water (MoFE, 2018). The primary inflow of water in Khaste Lake is from Neureni Lake and several seasonal rivulets. Taal Khola is the outlet of the Khaste Lake.

Figure 1
Khaste Lake

Samples Collection

One liter of water sample was collected from the lake during the first week of every month (May-August, 2021), from 11:00 am to 12:00 pm. The collected water samples were kept in clean sample bottles. Then, different physico-chemical parameters were examined in the chemistry laboratory within four hours of sample collection.

Physico-Chemical Analysis

The physico-chemical parameters were analyzed by using the standard operation procedure (SOP) (Table 1) to find out the quality of water of the lake for aquatic organisms. Depth of the lake was measured with the help of measuring tape by tying half kilogram weight on the rope and dropping it to the bottom of the lake. Transparency of lake water was observed with the help of Secchi disc instrument by finding out the average distance of just disappearance and reappearance of Secchi disc under the lake water. Temperature of water on the surface of the lake was noted by using standard mercury thermometer by immersing the bulb of the thermometer directly into the water on the surface.

The concentration of the dissolved oxygen in the water of the lake was determined with the help of Winkler's iodometric titration method by using reagent like manganese sulfate ($MnSO_4$), alkaline potassium iodide (KI), concentrated sulfuric acid (H_2SO_4) and sodium thiosulfate ($Na_2S_2O_3$) solution. The concentration of free carbon dioxide present in water was calculated by titration method using 0.05N sodium hydroxide (NaOH) solution and phenolphthalein as an indicator. The Microprocessor pH-meter was used to determine the hydrogen ion concentration of water samples of the lake. Similarly, the total alkalinity concentration of water samples was determined by the titration method using HCl (0.1N), phenolphthalein and methyl orange indicators.

Ethylene diammine tetra acetic acid (EDTA)-titration method was used to determine the total hardness of water sample using buffer solution, eriochrome black indicator and standard EDTA solution. The total solid (TS) materials present in the water samples were determined by weighing and evaporation method. Similarly, the total dissolved solid (TDS) was determined by filtering, evaporating and weighing method. The concentration of calcium and magnesium present in the water samples was determined by the titration method with the help of EDTA solution and murexide indicator. Chloride ions concentration was determined by using argentometric titration by employing the silver nitrate ($AgNO_3$) and potassium chromate (K_2CrO_4) solutions as indicator. All experiments were performed in triplicates involving volumetric titrations.

Table 1
Methods Used for the Determination of Physico-Chemical Parameters

Parameters	Methods employed
A. Depth (m)	Measuring tape
B. Transparency (cm)	Secchi disc method
C. Temperature (^{0}C)	Standard mercury thermometer
D. Dissolved oxygen (mg/L)	Winkler's iodometric titration Method
E. Free Carbon dioxide (mg/L)	Titration Method (NaOH method)
F. Hydrogen ion concentration	Microprocessor pH meter
G. Total alkalinity (mg/L)	Titration Method
H. Total Hardness (mg/L)	EDTA Titration Method
I. Total Solid (mg/L)	Evaporation Method
J. Total Dissolved Solid (mg/L)	Filtration and Evaporation
K. Calcium (mg/L)	Titration Method
L. Magnesium (mg/L)	Titration Method
M. Chloride (mg/L)	Argentometric Titration Method

Source: APHA, 1999

Some physical parameters such as depth, transparency and temperature were measured on the spot with the help of their respective instruments. For the investigation of chemical parameters like dissolved oxygen, free carbon dioxide, total hardness, total alkalinity, etc., the water samples were collected and brought to the chemistry laboratory of Prithvi Narayan Campus for the laboratory analysis. Standard chemicals and reagents, which were from Thermo-Fisher-Scientific, VEB-Research, Nice Chemicals, SD Fine, LOBA Chemia, Fasarabhain, Himedia Laboratory, etc., companies were used.

RESULT AND DISCUSSION

The collected data were presented in the form of tables and figures, using the names of chemicals and other materials:

Table 2
The Results Obtained from Analysis of Water Sample of Khaste Lake

S.N.	Parameters	Months				Average Values
		May	June	July	August	
1	Depth (m)	2.4	2.6	2.7	2.6	2.575
2	Transparency(cm)	60	35	30	40	41.25
3	Temperature(^{0}C)	26	27	29	31	28.25
4	Dissolved Oxygen(mg/L)	6.4	6.2	6.0	5.2	5.95
5	Free Carbon dioxide (mg/L)	4.0	4.3	4.3	4.4	4.25
6	Hydrogen ion concentration(pH)	6.8	6.6	6.4	6.5	6.575
7	Total Alkalinity (mg/L)	108	102	104	104	104.5
8	Total Hardness (mg/L)	124	128	130	134	129
9	Total Solid (mg/L)	95	119	120	115	112.25
10	Total Dissolved Solid (mg/L)	52	55	63	63	58.25

11	Calcium (mg/L)	17.5	18	20	22.5	19.5
12	Magnesium(mg/L)	7.5	8.0	8.5	10.0	8.5
13	Chloride (mg/L)	10.0	11.3	17.4	12.7	12.85

Table 3

Comparisons of Physico-Chemicals Parameters of Khaste Lake with Other Lakes

Lakes	pH	DO (mg/L)	F-CO_2 (mg/L)	TA (mg/L)	TDS (mg/L)	Cl^- (mg/L)	Reference
Khaste	6.575	5.95	4.25	104.5	58.25	12.85	Present Study
Begnas	9.04	6.46	13.32	-	25.42	20.04	Pant, et al., 2019
Rupa	7.87	5.09	14.83	-	36.70	16.52	Pant, et al., 2019
Deepang	7.3	6.8	3.9	111.0	-	-	Bastola et al., 2010
Maidi	7.3	6.2	3.4	91.1	-	-	Bastola et al., 2010
Nagdaha	7.8	7.09	31.7	-	106	27.07	Pant, 2013
Kamalpokhari	8.125	3.4	7.625	278.75	-	-	Bastola, 2012

Table 4

WHO Guidelines Values of Some Physico-Chemical Parameters of Drinking Water

Physico-chemical Parameters	**Guideline Value**
Dissolved Oxygen (DO)	5 mg/L
Free Carbon-dioxide (F-CO_2)	4-25 mg/L
Hydrogen ion concentration	6.5-8.5
Total Alkalinity (TA)	600 mg/L
Total Hardness (TH)	500 mg/L
Total Dissolved Solid (TDS)	500 mg/L
Calcium (Ca)	100 mg/L
Magnesium (Mg)	150 mg/L
Chloride (Cl^-)	250 mg/L

Source: WHO (2008)

The measured values of physico-chemical parameters of the lake water are presented in (Table 2). The obtained results are then compared with standard values of WHO and other lakes. The maximum depth of the Khaste Lake was found to be 2.7 m in July due to the heavy rain and consequent increase in the volume of water in the lake. The transparency of the water decreased in June and July compared to that in May which again slightly increased in August as compared to July. Transparency is a measure of the depth of light penetration in the water column. The value of transparency range was from 30-60 cm. The obtained value of transparency showed that the lake water was slightly polluted but it supports the aquatic lives. The temperature range was from 25^0C to 31^0C during the study period. The reason for the rise in temperature was hot weather at the time of data collection.

The dissolved oxygen (DO) observed throughout the study period was above or same as the minimum permitted level of 5.0 mg/L (WHO, 2008). The DO range was from 5.2 mg/L to 6.4 mg/L during the study period. The values of DO of different lakes mentioned above (Table 3) were similar to each other except Kamalpokhari. For the

existence of different aquatic organisms, the concentration of DO below 5 mg/L is considered to be insufficient (WHO, 2008). Thus, the obtained DO shows that the lake supports the aquatic lives. Free carbon dioxide in water depends upon the process of photosynthesis. Due to the respiratory activities of aquatic organisms and decomposition of organic materials by microbes, the concentration of carbon dioxide increases in the lake water (Bastola, 2012). The concentration of free carbon dioxide was found to vary from 4.0 mg/L in May to 4.4 mg/L in August in Khaste Lake. The concentration of free carbon dioxide of Khaste Lake was lower than Begnas, Rupa, Nagdaha and Kamalpokhari and was higher than Deepang and Maidi (Table 3). Thus, the obtained value of F-CO_2 meets the standard values of WHO (4-25 mg/L). The average value of DO and F-CO_2 were 5.95 mg/L and 4.25 mg/l respectively (Figure 3). The pH values of Khaste Lake were in the range between 6.4 and 6.8 (Figure 2). Comparing the pH of different lakes, Khaste Lake was found to be slightly more acidic than other lakes (Table 3). The average samples were within the pH permitted levels of 6.5 to 8.5 (WHO, 2008) (Table 4). Hence the obtained pH value is suitable for the aquatic lives. Alkalinity of water sample was due to the presence of carbonates, bicarbonates and hydroxide ions in the water. The present study showed that the total alkalinity of Khaste Lake was found in the range from 102 to 108 mg/L. The concentration of total alkalinity of Khaste Lake was lower than Kamalpokhari and Deepang but it was higher than Maidi (Table 3). Thus, the obtained values of TA were within the criteria of WHO. Similarly, the total hardness of water was found in the range from 124 mg/L–134 mg/L (Figure 2). The hardness depends on the amount of calcium and magnesium salt dissolved in the water. The water having hardness of 15 mg/L or above may be considered suitable for the growth of the aquatic animals and plants (Swingle, 1967).

Figure 2

Total Hardness (mg/L) and pH of Lake Water at Different Months

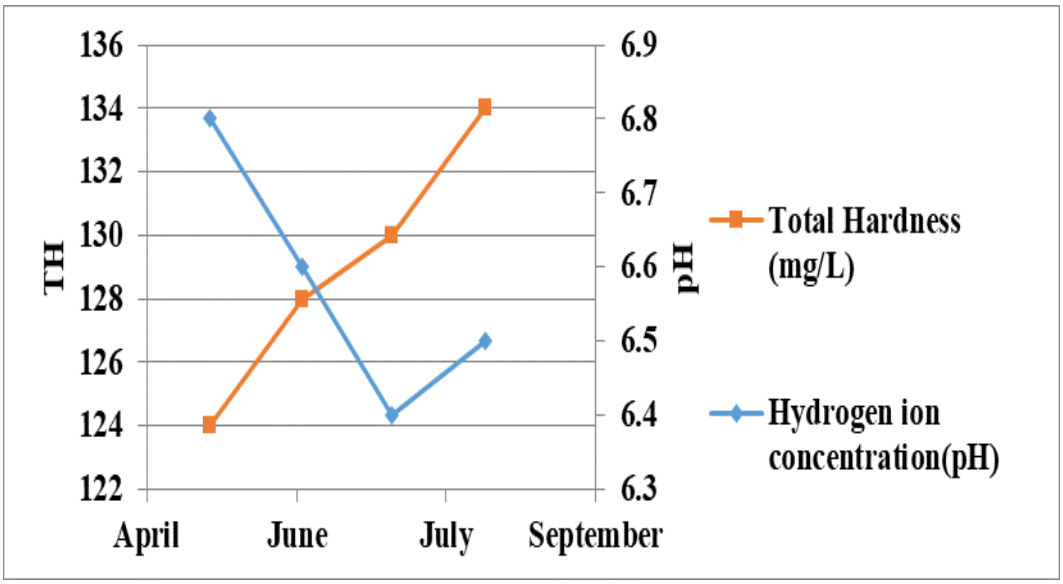
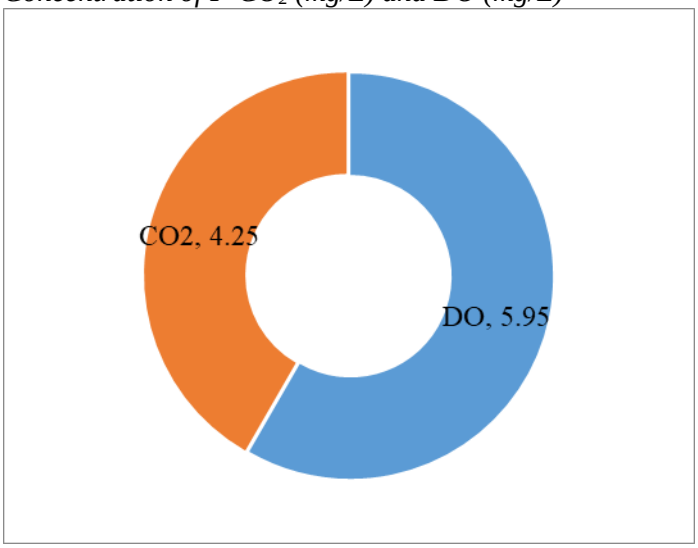


Figure 3

Concentration of F-CO_2 (mg/L) and DO (mg/L)



The total solid material present in the lake water was both organic and inorganic substances which were in the dissolved form and undissolved form. The total solid in Khaste Lake was found to be 95 mg/L to 120 mg/L. Similarly, the amount of total dissolved solid showed the various kinds of water soluble materials present in the water, which were both organic and inorganic substances (Khanal et al, 2021). The total dissolved solid varies from 52 mg/L to 63 mg/L. The total dissolved solid level less than 500 mg/L is considered to be good for aquatic environment (WHO, 2008). The TDS of Khaste Lake was greater than Begnas and Rupa while it was lower than Nagdaha (Table 3) due to the presence of organic and inorganic substances in dissolved form. Plants and animals of Khaste Lake were found not affected much by the content of total dissolved solids in water. The average values of TA, TS and TDS were 104.5 mg/l, 112.25 mg/l and 58.25 mg/l respectively (Figure 4). Calcium ion concentration was found higher in August (22.5 mg/L) and lower in May (17.5 mg/L). Due to the heavy rainfall and soil erosion in the month of August, calcium ions present in rocks and minerals of streams and rivulets come into the Khaste lake water. The calcium content of the water is directly related to the bicarbonates and both of these showed inverse relation with pH concentration (Pearsall, 1930). The highest concentration of magnesium observed in the lake was 10.0 mg/L in August and the lowest 7.5 mg/L in the month of May during the study period. The magnesium ions also have some contribution in the hardness of the lake water. The concentration of chloride ions was found to be in the range between 11.3 mg/L and 17.4 mg/L during the investigation in Khaste Lake. Comparing the presence of concentration of chloride ions of different lakes (Khaste, Begnas, Rupa and Nagdaha) (Table 3), Khaste Lake (12.85 mg/L) was found to have lower chloride ions than other lakes due to the low quantity of minerals like mica, apatite, fecal deposition and household sewage. The average values of Ca, Mg and Cl^- were 19.5 mg/l, 8.5 mg/l and 12.85 mg/l respectively (Figure 5). The concentration of calcium, magnesium and chloride are also within the range with reference to the WHO standard value (Table 4).

Figure 4

Concentration of TA, TS and TDS (mg/L)

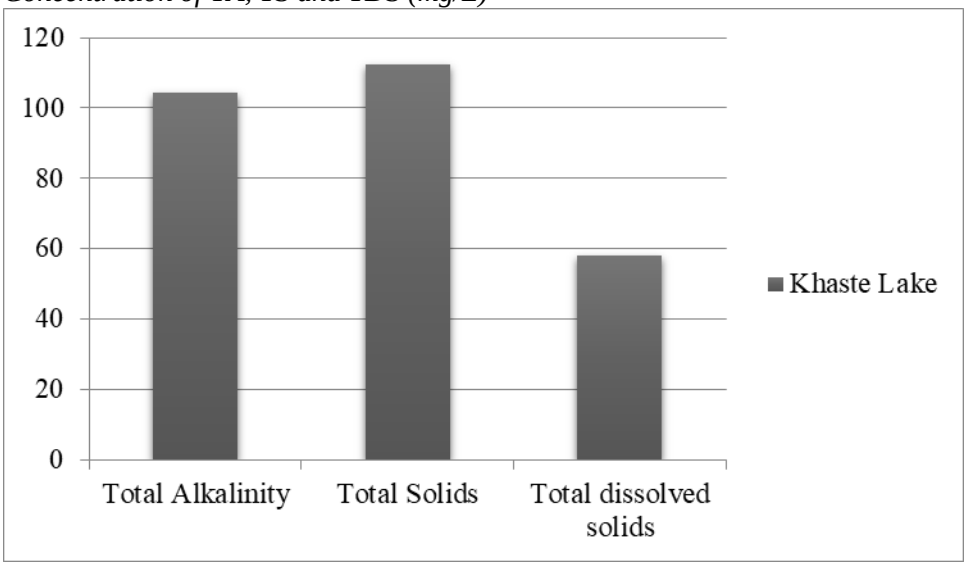
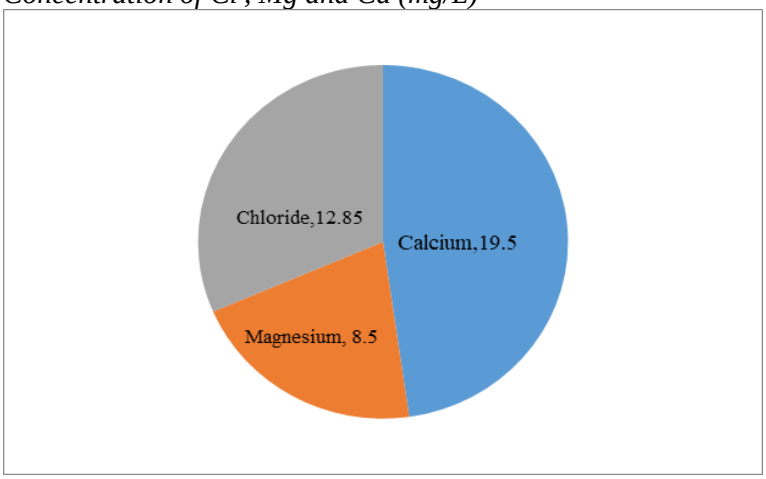


Figure 5

Concentration of Cl^-, Mg and Ca (mg/L)



LIMITATION OF THE STUDY

The available time period was not sufficient to carry out the research minutely. The research was performed by using traditional titration method. Thus, the precision of data could not be obtained.

CONCLUSION AND RECOMMENDATIONS

The study of abiotic i.e. physico-chemical parameters was carried out in Khaste Lake during the months of May to August 2021. The study focused on the assessment of physico-chemical parameters for aquatic environment. All these abiotic components meet WHO standard of water quality for aquatic ecosystem in Khaste Lake and hence suitable for aquatic environment and irrigation. After studying the prior mentioned physico-chemical parameters of the lake, it seems worth recommending that the local people should be aware about the importance of lake water, preservation and continual utilization of natural resources. Sapling should be planted in the barren land around the

lake to prevent the area from landslides and soil erosion. Programs like lake cleaning, banning of insecticides, pesticides and harmful chemicals use in the watershed area of lake, making siltation dam to control the rocky soil often coming during the rainy season and restriction on the disposal of domestic and other wastes into the lake.

ACKNOWLEDGEMENTS

I am thankful to the Centre for Research and Innovation (CRI), Prithvi Narayan Campus, Pokhara for providing me with the research grant to conduct this study and also express sincere thanks to the Department of Chemistry, Prithvi Narayan Campus, Pokhara for providing laboratory facilities to carry out the study.

REFERENCES

Association, A. P. (1999). *Standard methods for the examination of water and wastewater.* (A. G. L.S. Clesceri, Ed.) American Public Health Association, American Water Works Association, Water Environment Association.

Bastola, S. C. (2012). Abiotic and biotic Environment of Kamal Pokhari. *A Multi-Disciplinary Research Journal, 5*, 45-50.

Bastola, S. C., & Gurung, S. (2010). *Study on abiotic and biotic community of Dipang and Maidi Lake in Kaski District.* (Unpublished M.Sc. Dissertation). Central Department of Zoology, Tribhuvan University.

FDD. (1992). *National Fisheries Development Plan.* Department of Agriculture Development Fisheries Development Division, Kathmandu.

Khanal, L. N., Adhikari, N. P., Paudel, G., & Adhikari, S. (2021). Physicochemical assessment of leachate from Pokhara landfill site and its impact on the quality of Seti River water, Nepal. *Archives of Agriculture and Environmental Science , 6*(2), 194-201.

MoFE. (2018). Integrated lake basin management plan of lake cluster of Pokhara valley, Nepal (2018-2023). *Ministry of Forests and Environment*.

Noble, R., & W.J., W. (1984). *The ecological importance of Wetland.* In Proceeding of the 2nd conference on conservation of wetlands of Internatinal importance, Netherlands.

Pant, R. R. (2013). Water quality assessment of Nagdaha Lake, Lalitpur, Nepal. *Journal of University Campus Unit, 8*, 52-56.

Pant, R. R., Pal, K. B., Adhikari, N. L., Adhikari, S., & Mishra, A. D. (2019). Water quality assessment of Begnas and Rupa Lakes, lesser Himalaya Pokhara, Nepal. *Journal of the Institute of Engineering, 15*(2), 113-122.

Pearsall, W. H. (1930). Phytoplankton in the English lakes: The proportions in the waters of some dissolved substances of biological importance. *J. Ecol, 18*, 306-320.

Pennak, R. W. (1953). *Fresh Water invertebrates of the United States.* The Ronald Press.

RONAST. (2002). *Proceedings of International Seminar on Mountains, Kathmandu (March 6-8, 2002).* Royal Nepal Academy of Science and Technology (RONAST), Kathmandu.

Subramanyam, H. (1986). *Engineering Hydrology* (2nd ed.). Tata McGraw-Hill Publishing Company.

Swingle, H. S. (1967). Standarization of chemical analysis for water and pond muds. *FAO Fisheries Report, 4*, 397-421.

UNESCO. (1978). World water balance and water resources of the earth. *Studies and Reports in Hydrology, 25*, 663.

WHO. (2008). *Guidelines for drinking-water quality* (3rd ed., Vol. 1). World Health Organization.