AMC JOURNAL (DHANGADHI)
Year 8; June, 2025; Vol. 6; Issue 1; PP.11-19 DOI: https://doi.org/10.3126/amcjd.v6i1.82104

Determination of pH, Ammonia and Nitrate Level in Ghodaghodi Lake, Jokhar Lake and Geta Fisheries

Manoj Ojha

Lecturer of Chemistry, Department of Science
Aishwarya Multiple Campus, Dhangadhi, Kailali
E-mail: manojchem83@gmail.com

Article History: Received on: April 5, 2025, Accepted on: May 15, 2025

Abstract

The main aim of this research is to check the water quality for domestic purposes and survival of aquatic species. The present study was conducted in two representative lakes Ghodaghodi and Jokhar Lake of Kailali district and one Geta Fisheries. A total of 10 samples were collected from Ghodaghodi Lake, Jokhar Lake and Geta Fisheries and analyzed for water pH, ammonia and nitrate level in the pre monsoon season during 2024. The pH of water samples was determined by using bench top pH meter. It was found that Ghodaghodi Lake and Geta Fisheries were moderately alkaline and pH ranges from (7.0 -9.7) and (8.2- 9.6) respectively. The pH of Jokhar Lake was found to be in the range of (6.3-8.1).

The concentration of ammonia was found to be higher in Jokhar Lake which ranges from (0.1-0.32) mg/L in comparison to Ghodaghodi Lake (0.1-0.17) mg/L and Geta Fisheries (0.15-0.16) mg/L. On the other hand, the concentration of nitrate was found to be ranges from (3-5) mg/L in Ghodaghodi Lake and (2-3) mg/L in Geta Fisheries. The nitrate content was somewhat high in Jokhar Lake ranges from (5-7) mg/L. The pH range is 6.5–8.5, ammonia limit is 1.5 mg/L, and nitrate limit is 50 mg/L in both WHO 2019 and NDWQS 2023 standards. While comparing the different parameter with WHO and NDWQS 2079 drinking water guidelines, these three lakes, Ghodaghodi Lake, Jokhar Lake, and Geta Fisheries, were within the permissible limit standards for safe drinking water and aquaculture. Among all three, Geta Fisheries demonstrated the most stable water quality parameters across all measured indicators with score of 9±0.72 for pH, 0.15 ±0.005 for ammonia and 2.33±0.57 for nitrate. Overall, the lakes were relatively unpolluted and suitable for drinking purposes and fish farming but, special steps were taken in consideration to protect the lakes in their pristine conditions in the future.

Keywords: pH, ammonia, nitrate, Lakes, Fisheries, Kailali

Introduction

Ammonia is a toxic compound that can adversely affect aquatic animal health. It is a nutrient that contain nitrogen and hydrogen. The nature and degree of toxicity depend on many factors including the chemical form of ammonia, the pH and temperature of water, length of exposure and life stages of exposed fish (Randall, 2002). When dissolved in surface, ammonia exist in two form NH_3 (unionized) and NH_4^+ (ionized) (Floyd et al., 2009). Ionized ammonia does not easily cross fish gills and is less bio-available than unionized form. The unionized form can cross from water into fish and once inside some convert to ionized form which than causes cellular damage. The ammonia found in aquatic environment primarily originates from waste of fish and invertebrates. When these organic excrete nitrogen, a

significant portion is in the form of ammonia, which is released directly through gills. Even at, relatively low concentration, ammonia can be highly toxic within aquatic ecosystem, leading to the detrimental effects such as gill damage, skin irritation and in severe cases, mortality. Ammonia is toxic to aquatic organism but ammonium is nontoxic (Thurston et al.,1981). Ammonia when present in water are acutely toxic to fish which may cause problem such as loss of equilibrium, hyper excitability, increased breathing, cardiac output and oxygen uptake and in extreme cases, convulsions, coma and death. (Levit, 2010).

Ammonia can enter the aquatic environment via direct means such as municipal effluent discharge and excretion of nitrogenous wastes from animals and indirect means such as nitrogen fixation, air deposition and run off from agriculture land (EPA, 2013).

Another nitrogenous component which is present in surface water sources is nitrate. Nitrate present in fresh water resources retard the oxygen carrying pigment in aquatic organism. Nitrate is more sensitive to fresh water than marine animal (Camargo et al., 2004). Nitrate are essential plant nutrients but in excess amount they can cause significant water quality problem. Along with phosphorous, excess amount of nitrate can speed up eutrophication, causing sharp increase in aquatic plant growth and changes in types of plant and animals that live in stream. As a result, it affects dissolved oxygen, temperature and another indicator. Excess nitrates can cause hypoxia and become toxic to warm blooded animal at higher concentration (EPA, 2013). Exposure to high concentration of nitrate causes gills lesions and edema in the skeletal muscles of fish, but its most effect is on respiration (GSFA, 2014).

Eutrophication degrades the water quality in aquatic ecosystem which is caused by nitrate and phosphate run off from farmlands, effluent from aquaculture ponds as well as municipal and industrial discharge (Carpenter, 2008; Akinnawo, 2021). Nitrate and phosphate fertilizer from agricultural run-off resulted in a dense growth of aquatic plants and algal bloom (Knight, 2021). Eutrophication occurs when an excess of nutrients accumulates in a body of water, leading to harmful algal blooms, fish deaths, and, in some cases, disruptions to the ecosystem. It alters the nutrients balance, impacting organisms and degrading water quality (NOAA,2007; UNEP,2015). Excess nutrients from agricultural and municipal wastes lead to algal growth, which releases toxic substances, rendering fish and other seafood unsafe for human consumption (UN, 2017).

Amount of nitrate and ammonia varies with geographical distribution. Nitrate content in Ghodaghodi Lake varies from (0.01-0.62mg/L) and Rara lake was 0.20mg/L. Similarly, ammonium content in Ghodaghodi Lake varies from (0.47-1.55mg/L) and that of Rara Lake was ranges from (0.00-2.58mg/L) (Bhatta et al., 2022). Ghodaghodi Lake situated at Ghodaghodi municipality is surrounded by human habitat and agricultural land was mildly alkaline and major anion present are bicarbonate ion, sulphate ion, chloride ion and nitrate ions (Pant et al., 2020).

The variation in various parameter in water are due to various anthropogenic and natural processes(Pant et al., 2021).pH is another factor to maintain water quality for survival of aquatic life whose value can be changed due to presence of organic and inorganic solute together with reaction of CO_2(Pant et al., 2019). pH is an important parameter in aquaculture which measure the acidity of water or soil. Water below pH 4 and above pH 10 is unfavorable for survival of fish. The optimum pH for survival of fish is between (6.5-9) (Raval et al., 2024).

Table 1

Standard limit for drinking water according to WHO 2022 and NDWQS, 2079 Nepal

Parameter	**WHO 2019**	**NDWQS 2023**
pH	6.5-8.5	6.5-8.5
ammonia	1.5mg/L	1.5mg/L
nitrate	50mg/L	50mg/L

Nepal is known for its numerous lakes, ranging from small, high-altitude lakes to larger bodies of water. These lakes are spread across different regions of the country including the Himalayas mid-hills and Terai plains. Lakes are important freshwater ecosystems supporting various aquatic life including fish species. Kailali is a district of Sudurpaschim province and is located in southwest Nepal. The major lakes of the Kailali district are Ghodaghodi Lake and Jokhar Lake etc. Fish in lakes carry out their vital activities including respiration, digestion, excretion, and temperature regulation. Lakes provide a diverse and relatively stable ecosystem. There are various parameters that can be observed in lakes. In this research, I have chosen three representative lakes of the Kailali district to determine pH, nitrate and ammonia levels.

Methods and Methodology

Research Design

This study attempts to determine the pH, concentration of ammonia and nitrate in different lakes of the Kailali district. The main motto of the research is to identify the effect of pH, ammonia, nitrate levels on water quality for survival of aquatic life and for drinking purpose. For the research study, water sample were collected from the 3 representative lakes the Ghodaghodi Lake, Jokhar Lake, and Geta Fisheries of the Kailali district. The data were collected, analyzed, compared and tabulated according to the need of research. This research is therefore descriptive and experimental in nature.

Study Area

Kailali district, a part of Sudurpashim province Terai plain and covers an area of 3225 KM square. There are 13 local bodies of which one is a sub-metropolitan city, 6 are municipalities and 6 rural municipalities. The three representative lakes are Ghodaghodi Lake, Jokhar Lake and Geta Fisheries.

Ghodaghodi Lake lies between$28^{\circ}41'17''N, 80°56'47''$E, is situated in Kailali district of Sudurpaschim Province of Nepal. It covers an area of 2563 hectares at an altitude of 205m from sea level. The people living around this wetland use this Lake for fishing, timber, irrigation and other resources (Lamsal et al., 2015).

Jokhar Lake which lies between, $28°42'6''N$,$80°34'03''E$, is in Dhangadhi sub-metropolitan city 07 Kailali. It covers an area of 12.45 hectares. This lake could be used for crocodile and tortoise farming along with fish farming.

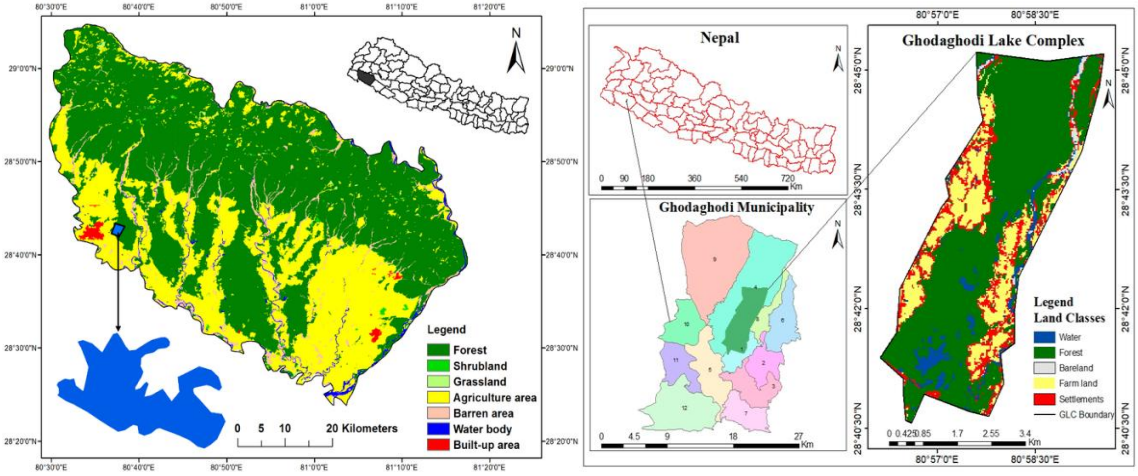
Geta Fisheries is located 9 km north of Dhangadhi sub-metropolitan city and 5 km south of Attariya on Mahendra Highway. This center is located at 80º east longitude and 28º north latitude which covers the area of 12.856 hectares. The purpose of this center is to produce and sell advanced fish product and

Year 8; June, 2025; Vol. 6; Issue 1; PP.11-19 DOI: https://doi.org/10.3126/amcjd.v6i1.82104

supporting the growth of national fish production with the involvement of private sector. The fish seeds produced from this center are being sold and distributed in Banke and Bardia districts besides this province (www.fdckailali.gov.np)

Figure 1

Map showing the study area of Jokhar Lake and Ghodaghodi Lake of Kailali



Water sample collection and preservation.

Four water samples were collected in cleaned HDPE sampling bottles from different site (namely near about center part, outlet at southern part, eastern part and western part near temple) of Ghodaghodi Lake, three water samples from different sites of Jokhar Lake and three water samples from three different ponds of Geta Fisheries. The samples were handled with care to minimize contact with air and filled the bottle to the brim in order to prevent ammonia loss. The samples were delivered to the laboratory as soon as possible. The samples were stored and transported in cool conditions around 4°C to prevent direct sunlight and minimize biological activities and ammonia change. The measurement of temperature, pH, ammonia and nitrate were done in the laboratory of Department of Water Supply and Sewage Management, Dhangadhi. Water quality parameters were analyzed by following standards methods.

Table 2

Methods used for determination of physico-chemical parameters

Parameters	**Methods**
Temperature	Mercury thermometer
pH	Digital Table Top pH meter
Ammonia	Ammonia Test Kit
Nitrate	"4500-NO_3-B", APHA 22nd edition

Year 8; June, 2025; Vol. 6; Issue 1; PP.11-19 DOI: https://doi.org/10.3126/amcjd.v6i1.82104

Results and discussion

The Ghodaghodi Lake and Geta Fisheries were moderately alkaline and value ranges from (7.0-9.7) and (8.2-9.6) respectively. The data in the table shows that pH range of Jokhar Lake was slightly acidic (6.3) to alkaline (8.1). One of the samples J_3 at periphery was slightly acidic having pH 6.3. In comparison to Ghodaghodi Lake and Geta fisheries, the water quality of Jokhar Lake goes on decreasing and in near future it will not be suitable for aquatic life.

Table 3

Physico-Chemical Parameters (pH, Ammonia, and Nitrate Levels) of Water Samples from Ghodaghodi Lake, Jokhar Lake, and Geta Fisheries at 25℃

Lake		pH	ammonia(mg/L)	nitrate(mg/L)
Ghodaghodi	G1(near about central region)	9.6	0.1	3
	G2(outlet southern part)	7	0.17	5
	G3(western part periphery)	9.7	0.15	3
	G4(eastern part periphery)	7.3	0.09	3
	mean	8.4	0.1275	3.5
	SD	1.44	0.03	1
Jokhar	J1(near about central part)	8	0.24	5
	J2(periphery)	8.1	0.32	7
	J3(periphery)	6.3	0.1	6
	mean	7.46	0.22	6
	SD	1.01	0.11	1
Geta Fisheries	F1	9.2	0.15	2
	F2	9.6	0.15	3
	F3	8.2	0.16	2
	mean	9	0.15	2.33
	SD	0.72	0.005	0.57

The average concentration of ammonia in Ghodaghodi Lake was 0.13mg/L. The amount of ammonia is high at outlet in southern part which could be due to human activities where movement of people is frequent and less amount was found in the near about central region. The average concentration of ammonia in Geta Fisheries was 0.15mg/L. In contrast to these two lakes, high amount of ammonia was found in Jokhar Lake and was ranges from less than 0.1mg/L to 0.32mg/L but lies within the permissible limit for drinking water according to NDWQS, 2079. In pristine water environments, ammonia levels should ideally remain undetectable, as their presence suggests an imbalance within the system. As the concentration of ammonia surpasses 0.05 mg/L, it progressively inflicts harm. At 2.0 mg/L, delicate

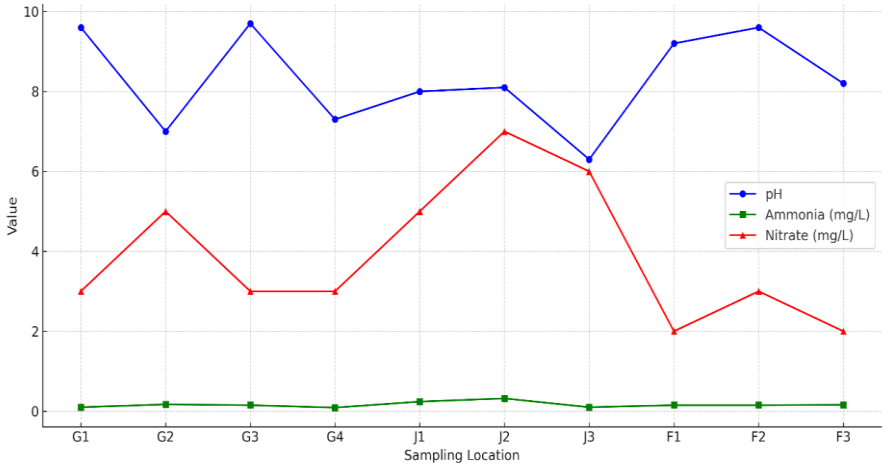
Year 8; June, 2025; Vol. 6; Issue 1; PP.11-19 DOI: https://doi.org/10.3126/amcjd.v6i1.82104

fish species typically perish. Furthermore, even if fish don't die directly from elevated ammonia levels, they become more vulnerable to contracting infectious diseases (Floyd et al.,2022).

In comparison to Geta Fisheries, Ghodaghodi lake and Jokhar Lake has high concentration of nitrate ranging from (3-5) mg/L and (5-7) mg/L respectively. The maximum amount of nitrate level for protection of aquatic life is 2mg/L (Camargo et al., 2004). This high concentration would result in nitrate toxicity for aquatic species.

Figure 2

Comparative Analysis of pH, Ammonia, and Nitrate in Ghodaghodi Lake, Jokhar Lake, and Geta Fisheries at 25℃



The pH values, ammonia concentration and nitrate level of all these three lakes were in the permissible limit for drinking water according to WHO,2022 and NDWQS,2079. Despite this, the water is going to be polluted due to anthropogenic activities in nearby settlement. Ghodaghodi and Jokhar Lake is the main destination for tourist. They visit these lakes for religious purpose or for celebrating different ceremonies such as birthday party, marriage anniversary parties etc. The wastes from these activities could run off towards these water sources and pollute the lake which result in the enrichment of nitrate and ammonia. Area nearby these lakes is highly dense and people living there are engaged in agriculture. Agriculture run off such as chemical and organic fertilizer and leakage of sewage from households could be other cause to decline quality of water.

Beside above activities, the enrichment of nitrate and ammonia in these water resources could be due to disorganized quadrupeds such as cows or stray animals. The dwelling place of disorganized quadrupeds such as cow or stray animals is around these water resources. The animal excreta could run off towards these sources which aids in enrichment of nitrate and ammonia. This results in eutrophication which directly affect the aquatic life by decreasing the level of dissolved oxygen and could create problem for survival of fishes.

Statistical analysis

Microsoft Excel and SPSS were used for descriptive statistical analysis for calculating mean and standard deviation (SD) to evaluate central tendency and variability. Ghodaghodi Lake exhibited the

greatest pH variability (mean 8.4, SD 1.44), indicating spatial heterogeneity, while Geta Fisheries showed consistently elevated pH levels (mean 9.0, SD 0.72). Jokhar Lake recorded the highest mean concentrations of ammonia (0.22 mg/L) and nitrate (6 mg/L), with comparatively higher standard deviations, suggesting greater chemical variability. In contrast, Geta Fisheries demonstrated the most stable water quality parameters across all measured indicators.

Conclusion

This study was done to check water qualities by measuring pH, ammonia and nitrate level in three lakes, Ghodaghodi Lake, Jokhar Lake and Geta Fisheries where there are many more possibilities for aquaculture. The Ghodaghodi lake was moderately alkaline having pH ranges from (7.0-9.7) while pH of Geta Fisheries ranges from (8.2-9.6). This study had shown that one of the samples from Jokhar Lake has lower pH of 6.3 (acidic). This revealed that this lake is going to become acidic and gets highly polluted in near future. The concentration of ammonia was high in the samples of Jokhar Lake ranging from (0.1-0.32) mg/L in comparison to other samples which suggest that if not taken proper attention to protect this lake, there will arise serious problem in near future for survival of aquatic species. Ammonia served as a significant waste byproduct from fish and was also generated through the breakdown of feed and other organism. This study had shown that nitrate present was high in water sample of Ghodaghodi and Jokhar Lake ranging from (3-7) mg/L in comparison to Geta Fisheries where average value was found to be 2.3mg/L.

While comparing the different parameter with WHO and NDWQS 2079 drinking water guidelines, these three lakes, Ghodaghodi Lake, Jokhar Lake, and Geta Fisheries, were within the permissible limit standards for safe drinking water and aquaculture. However, there are concerns regarding the declining pH levels and rising concentrations of nitrate and ammonia, which may pose future challenges. The presence of ammonia was seen in all water samples which indicate that the system was proceeding towards out of balance. Overall, the lakes were relatively unpolluted and suitable for drinking purposes and fish farming but, special steps were taken in consideration to protect the lakes in their pristine conditions in the future. Therefore, it is essential to address these factors, particularly due to the various anthropogenic activities occurring around the lakes. This research provides valuable insights into maintaining the sustainable water quality of these three bodies of water.

Recommendations

In well-maintained lakes and ponds, ammonia levels should consistently register at zero. The presence of ammonia signals an imbalance within the system. When ammonia is detected in a pond or lake, the initial step is to decrease or halt feeding. Fish may not eat during periods of ammonia stress, and any uneaten feed will exacerbate the situation. Temporarily reducing or discontinuing feeding for 1-3 days generally will not adversely impact fish. Excessive feeding is a primary contributor to elevated ammonia concentrations. So, pH, ammonia, nitrate and other physical or chemical parameter in water resources should be tested more frequently. It will be better to establish a properly designed and sized biofilter for long term management of ammonia in water.

Local government should allocate sufficient budget for management of water resources. Government should aware the people about the negative effect of polluted water. Awareness program should be launched frequently. Government should focus on the waste management system near natural or man-

made lakes and ponds. If these water sources were polluted, it aids in global warming which is the worldwide burning issues. Local government should make policies and strictly focused on implementation to banned anthropogenic activities in the vicinity of lakes and water reservoirs. In addition to these, one of the burning issues is disorganized quadrupeds such as cow near water resources which aids in contamination of water with their excreta. Government should manage these types of animals properly as soon as possible.

Acknowledgement

I would like to thank Research Management Cell, Aishwarya Multiple Campus for providing fund for this research. I am also grateful and indebted to Aishwarya Multiple Campus, Dhangadhi for laboratory support to conduct my work. I would like to thank Chemist Prakash Bhandari, Department of Water Supply and Sewage Management, Dhangadhi for his technical support. My special thanks go to residents of study sites for their valuable cooperation.

References

Akinnawo, S. O. (2023). Eutrophication: Causes, Consequences, Physical, Chemical and Biological Techniques for Mitigation Strategies. *Environmental Challenges*, 100733. https://doi.org/10.1016/j.envc.2023.100733

Bhatta, R., Gurung, S., Joshi, R., Tuladhar, S., Regmi, D., Kafle, B. K., ... & Sharma, C. M. (2022). Spatio-temporal hydrochemistry of two selected Ramsar sites (Rara and Ghodaghodi) of west Nepal. *Heliyon*, *8*(11). https://doi.org/10.1016/j.heliyon.2022.e11243

Camargo, J. A., Alonso, A., & Salamanca, A. (2005). Nitrate toxicity to aquatic animals: a review with new data for freshwater invertebrates. *Chemosphere*, *58*(9), 1255–1267. https://doi.org/10.1016/j.chemosphere.2004.10.044

Carpenter, S. R. (2008). Phosphorus control is critical to mitigating eutrophication. *Proceedings of the National Academy of Sciences*, *105*(32), 11039-11040. https://doi.org/10.1073/pnas.0806112105

EPA (08/22/2013). Aquatic life ambient water quality criteria for ammonia-fresh water.US Environmental protection Agency

Francis-Floyd, R., Watson, C., Petty, D., & Pouder, D. (2022). Ammonia in Aquatic Systems: FA-16/FA031, 06/2022. *EDIS*, *2022*(4). https://doi.org/10.32473/edis-fa031-2022

Francis-Floyd, R., Watson, C., Petty, D., & Pouder, D. B. (2009). Ammonia in aquatic systems. *UF/IFAS University of Florida (UF)/Institute of Food and Agricultural Sciences (IFAS), FA*, *16*, 1-4. https://doi.org/10.32473/edis-fa031-2009

Global Sea Food Alliance (2014). Nitrite toxicity affected by species susceptibility, environmental conditions. http://www.globalseafood.org

Husen, M. A., Yadav, C. N. R., Shreshtha, M., & Bista, J. D. (2012). Growth and production of planktivorous fish species in cages stocked as monoculture and polyculture at Khapuadi in

Phewa Lake, Nepal. *Asian Fisheries Science*, *25*(3), 218-231. http://doi.org/10.33997/j.afs.2012.25.3.001

Knight, C. A. (2021). Causes and Consequences of Eutrophication, which are leading to Water Pollution. *J. Prev. Med*, *6*(10), 118-119. http://doi.org/10.36648/2572-5483.6.10.118

Levit, S. M. (2010). A literature review of effects of ammonia on fish. *Montana*.

NOAA (2007). National Estuarine Eutrophication Assessment: Update. National Centers for coastal Ocean Science, National Oceanic and Atmospheric Administration (NOAA).

Pal, K. B., Bishwakarma, K., Chalaune, T. B., Upadhaya, D., Joshi, T. R., Thapa, L. B., ... & Pant, R. R. (2021). Hydrochemical assessment of Jhilmila Lake, Kanchanpur, Nepal. *Scientific World*, *14*(14), 124-131. https://doi.org/10.3126/sw.v14i14.35023

Pant, R. R., & Adhikari, N. L. (2015). Water quality assessment of Phewa Lake, Pokhara Nepal. *Cogn Transdiscipl Res J*, *1*, 130-140.

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. https://doi.org/10.3126/jie.v15i2.27655

Pant, R. R., Pal, K. B., Bishwakarma, K., Thapa, L. B., Dangol, A., Dawadi, B., ... & Bhatt, Y. R. (2020). Application of multivariate approaches to the hydro-chemical assessment of the Ghodaghodi lake, sudurpaschim province, Nepal. *Nepal Journal of Science and Technology*, *19*(2), 46-54. https://doi.org/10.3126/njst.v20i1.39390

Paudel, G., Dahal, B., Pant, R. R., Bishwakarma, K., Sharma, S., Shrestha, S. M., ... & Awasthi, M. P. (2022). Assessment of hydrochemical characteristics of the Taudaha lake, Kathmandu, Nepal. *Scientific World*, *15*(15), 70-85. https://doi.org/10.3126/sw.v15i15.45651

Randall, D. J., & Tsui, T. K. N. (2002). Ammonia toxicity in fish. *Marine pollution bulletin*, *45*(1-12), 17-23. https://doi.org/10.1016/S0025-326X(02)00227-8

Raval, A. D., Das, B. K., Koley, S., & Saha, S. (2024). Effect of extreme high and low water pH on survival and behavioral changes of *Labeo rohita*. *International Journal of Advanced Biochemistry Research*, *8*(4), 595–602. https://doi.org/10.33545/26174693.2024.v8.i4h.1020

Thurston, R. V., Russo, R. C., & Vinogradov, G. A. (1981). Ammonia toxicity to fishes. Effect of pH on the toxicity of the unionized ammonia species. *Environmental science & technology*, *15*(7), 837-840. https://doi.org/10.1021/es00089a012

UNEP (2015). Mediterranean Action Plan. Report of the Online Groups on Eutrophication, Contaminants and Marine Litter. United Nations Environment Programme (UNEP).

United Nations (2017). The Untapped Resource- The United Nations World water development Report 2017. http://wedocs.unep-org/20.500.11822/20448

http://www.nwash.gov.np http://www.fdckailai.gov.np