JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

STUDY OF MONTHLY VARIATIONS IN SELECTED PHYSICO-CHEMICAL PARAMETERS OF MANIKA LAKE WATER AT MUZAFFARPUR, BIHAR (INDIA)

Ragini Kumari
Research Scholar
University Department of Botany,
B.R.A. Bihar University, Muzaffarpur, Bihar, 842001 (India)

ABSTRACT:

Selected physico-chemical parameters of Manika Lake water were studied from January 2016-Decebmer 2016, to evaluate the purity of water of the Lake water. Here Temperature ranged between 10^0C to 36^0C, pH 7.5 to 8.3, Turbidity 38.0 NTU to 54.0 NTU, Alkalinity 124 mg/l to 158 mg/l, Hardness 118.0 mg/l to 158 mg/l, Dissolved Oxygen 4.3 mg/l to 8.7 mg/l, BOD 2.0 to 4.38, COD 22.6 to 48.4, Concentration of Potassium 3.2 mg/l to 4.6 mg/l, Nitrogen 0.21 mg/l to 0.41 mg/l, Phosphorus 0.14 to 0.42 mg/l and Electrical Conductivity from 248.62µS/cm to 560.36µS/cm respectively. From the data obtained here, it was noted that except few parameters such as Dissolved Oxygen was below the standard as given by WHO for fresh water during summer. Similarly, the value of Electrical Conductivity was above the given standard value from the month of June to December. Other parameters were within the limits.

KEY WORDS: Manika Lake Water, Monthly Variations, Physico-Chemical Parameters, Purity of water, Standard Value

INTRODUCTION:

Manika Lake water is being used by the locals, for bathing, washing, fish farming and irrigation. The purity of water is day to day deteriorating because of dumping of domestic wastes both solid and liquid, direct run off of rain water from the agricultural lands, dumping of remains of worship materials and other domestic products by the villagers. The population growth, changes in life styles and negligence of this precious gift of nature, all have make the water unfit for common people for use. (Kupoluyi *et al*; 2018; Mushtaq *et al*; 2020; and Saha *et al*; 2021). The chemical, physical and biological aspects of water are known as water quality (WQ) (Khan *et al*; 2017). The biological activities results in the decomposition of litter in the aquatic systems (Kumar and Saikia, 2021). This in turn influences the water quality (WQ) mainly BOD and Dissolved Oxygen. According to Salomova (2021), the water quality is responsible for human health and water borne diseases. Consumption of such polluted water causes several diseases to mankind (Carbal pinto *et al*; 2020), Eugwa, Ferdinand and Unachukwu (2019). Trombadore, reported that about 80% rural people in India do consume such polluted water and suffer from different water borne disease. They further reported that only diarrhoea causes six lakhs annual death in India itself. Manika Lake water is also degrading day to day due to human activities and rain water runoff during rainy season from the coastal agricultural fields.

Physico-chemical analysis of different water bodies have been done by several workers. Some of them are being mentioned here. Such as Naik and Purohit (1996); Boyd (1981); Dwivedi and Pandey (2002); Sukesh Kumar (2003); Sachidananda murthy and Yajurvedi (2004); Shah *et al* (2006); Chaurasia and Pandey (2007); Kiran (2010); Kataria *et al*; (2011); Kavita and Yadav

(2012); Nirmala *et al*; (2012); Mahajan and Tank (2013); Harney *et al*; (2013); Begum *et al*; (2014); Hawes *et al* (2014); Dixit *et al*; (2015); Karaemer *et al*; (2015); Team and Zabib (2016); Sharma *et al*; (2017); Ranjan *et al*; (2017); Ramnathan and Amsath (2018). The study of physico-chemical parameters of water is important to observe the functional relationship and productivity of aquatic ecosystem as they are regulated by the dynamics of their chemical, physical and biotic environment (Boyd, 1981). In order to evaluate the quality of water bodies and for their management and effective utilization, there are need to study the physico-chemical parameters either monthly or season wise. This will help to main them within optimum range (USEPA, 1989).

In the present study Manika Lake water samples were collected monthly. The sample have been analyzed for different physico-chemical characteristics such as temperature, pH, turbidity, alkalinity, Hardness, Dissolved Oxygen, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Chloride, Potassium, Nitrate, Phosphate and Electrical Conductivity etc. in the year 2016.

MATERIALS & METHODS:

Temperature was measured with laboratory thermometer 100^0C. pH was measured with the help of digital pH meter. Turbidity was measured in the laboratory with the help of turbidity meter. Dissolved oxygen was measured with Winkler's method. Here, 300 cc BOD bottle was used. Before use the bottle was washed properly and before use was rinsed with sample water at the study site. The bottle was completely submerged inside the Lake water. Inside the cork was removed and water was allowed to completely fill the bottle so that there was no air space. The cork was placed again and bottle was taken out of the Lake water. At the bank the dissolved oxygen was fixed by adding 2 ml $MnSo_4$ + 2 ml alkali iodide azide, followed by addition of 2 ml sulfuric acid. The cork was placed again and in the laboratory, the sample water was titrated with 0.025N sodium thiosulphate, using starch as an indicator. Alkalinity, hardness, BOD, COD, all was determined by titrimetric method following methodology as described in APHA (2005). Similarly, chloride was calculated with titration. Potassium was also calculated the titration. Nitrogen was calculated with the Kjeldahl method. Electrical Conductivity was measured with conductivity meter. The unit is µS/cm.

RESULTS AND DISCUSSION:

Temperature of pond water depends on the air temperature, depth of the water body and duration of sun light falling on the surface. Due to this in the present study, a great variation in temperature ranged was noted from January to December. The highest temperature of Lake Water 36^0c was noted in the month of June because this month is the hottest month of the year. Similarly, lowest temperature was 10^0c in January because this is the coldest month of the year. pH of the Lake water was also the maximum 8.3 in this month, while it was lower in the month of September, that pH ranged between 7.4 to 8.3. Turbidity of the Lake water ranged between 38.0 NTU to 56.0 NTU. Here the lowest value was found in the month of October, while the highest value was noted in the month of May respectively. Alkalinity off the Lake water ranged between 124 mg/l to 158 mg/l from January to December of the study period. Here lowest value was found in January while the highest in the months of May and August respectively. Hardness of water ranged between 122.0 mg/l to 158 mg/l. Here the lowest value was noted in the month of March while the highest in the month of April respectively. The dissolved oxygen of the Lake water was also calculated. Here, the maximum value 8.7 mg/l was observed in the month of January, while the minimum value 4.3 mg/l was observed in the month of June itself. So value of Dissolved Oxygen ranged between 4.3 mg/l to 8.7 mg/l respectively Biological Oxygen Demand or BOD ranged between 2.0 mg/l to 4.38 mg/l. Here the lowest value was observed in the month of November while the highest value in February respectively.

Chemical Oxygen Demand of the Lake water was also calculated. It ranged between 22.6 mg/l to 48.4 mg/l from January to December in the study year. Concentration of potassium in the Lake water was also calculated which ranged between 3.2 mg/l to 4.6 mg/l respectively. The value of nitrate in the pond ware ranged between 0.21 mg/l to 0.41 mg/l receptively from January to December. Similarly, concentration of phosphorous ranged between 0.14 mg/l to 0.42 mg/l from January to December of the study year. The Electrical Conductivity of Lake water ranged between 248.62µS/cm to 560.36µS/cm respectively from January to December. So from the table-1, it may be noted that all the parameters studied here varied considerably from January to December of the study year.

DISCUSSION:

The value of surface water temperature is directly related with the value of air temperature. Water temperature influences the physiology of the organism living in the water body. It influences the

biochemical reactions by influencing the enzyme activities. High temperature may increase the toxicity of many substances such as heavy metals in water for domestic use. The value obtained in this study was higher than that of the recommended WHO (2006) standard of 25^0C from March to October of the study year. High water temperature enhances the growth of microorganisms and cause changes in taste, odor, colour and concentration of dissolved oxygen. This may also reduce the efficiency of settling of solids that the waste may contain, because of the resistance that high viscosity offers to the downward motion of the particles as they settle. (Jayalakshami *et al*; 2011; Team and Zebib, 2016). pH of the Lake water was also observed. It was mostly alkaline and highest pH was in the month of January that was 8.3. Present findings are in agreement with the findings of Wani *et al*; (1990); Nandan and Patel (1992); Singh *et al*; (2023). Turbidity in water refers to the cloudiness caused by the suspended particles. It is optical characteristic off water. It is a measure of the concentrations of the smallest particles that do not settle. It may also be caused by phytoplanktons consumption of turbid water may cause different diseases. Even fishes are affected with high turbidity. In the present findings high turbidity was noted in the month of June that was 56 NTU.

Alkalinity is a measure of the capacity of water to neutralize acids. Bicarbonates, (Baking Soda) Carbonates and hydroxides remove H^+ ions and lower the acidity of water, and thus pH is increased. In the present study the alkalinity ranged between 124 mg/l to 158 mg/l. Present findings are in agreement with the findings of Engwa *et al*; (2019); Bhat and Pandit (2020); Dey *et al*; (2021).

Hardness refers to the concentration of dissolved minerals, primarily calcium and magnesium in water. Hard water is high in dissolved minerals. Here bicarbonates, chlorides and sulfates of calcium and magnesium are important. In the present study, monthly variations in hardness of Manika Lake water was determined which ranged between 136 mg/l to 158 mg/l respectively. Maximum value was observed during summer. Present findings therefore, corroborate with the findings of Kumar (1995); Nair (2002); Hulyal and Kaliwal (2011) and Singh *et al*; (2023). Dissolved Oxygen is the free oxygen present in water. It may be absorbed from the atmosphere or be released by the photosynthetic organisms in the aquatic ecosystem. Because temperature influences the capability of oxygen to be dissolved in water therefore, during summer it was only 4.3 mg/l while in winter it was 8.7 mg/l. 4.3 mg/l is below the standard fixed by WHO. Present findings are supported by the findings of Halim *et al*; (2018); Rani (2019); Mushtaq *et al*; (2020); Salomova (2021) and Prasanjit *et al*; (2022). The Bio Chemical Oxygen Demand of the Lake water might alter the oxygen cycle and the oxygen balance. This BOD increase may cause depletion of oxygen in the water bodies. BOD observed was lower during low oxygen contents in water. Similar findings have been reported by Harney *et al*; (2013). Hawes *et al*; (2014); Chemical Oxygen Demand (COD) indicates the presence pollutants which are being oxidized chemically. It also requires oxygen for the reactions. Here it varies between 22.6 mg/l to 48.4 mg/l. Liu *et al*; (2020) reported that COD is a good indicator of water bodies. Value of COD is directly related with the concentration of soluble organic compounds. In general COD is generally higher than BOD as more organic compounds are oxidized chemically than biologically.

Concentration of potassium was also studied in the study period. Its concentration ranged between 3.2 mg/l to 4.6 mg/l from January to December. The amount of pond water was under the standard as is recommended for the fish pond (Kavita and Sheela, 2012). Nitrate concentration in the present work also varied from January to December. The concentration of nitrate ranged between 0.21 to 0.41 mg/l Here lower concentration was noted in the month of December and January. All organisms require nitrogen for the basic process of life. Presence of nitrates in the water sample is suggestive of some bacterial action and bacterial growth. Above findings are supported by the findings of Majumdar *et al*; (2006); Kavita and Sheela (2012). The concentration of phosphorus was also studied in different months of the year. Here the concentration varied from 0.14 mg/l to 0.26 mg/l respectively. Chemical fertilizers are the main source of phosphorous in aquatic ecosystem as the residues are brought here along with the rain water runoff during the rainy season. It is reported that phosphate level over 0.4 to 1.5 mg/l are not suitable for a fish pond. They can promote growth of different weeds. (Hepher and Pruginin, 1981, Mukherjee *et al*; 2022). Electrical Conductivity of Manika Lake water ranged between 248.62µS/cm to 560.36µS/cm respectively. Electrical conductivity is the ability of an aqueous solution to conduct electric current. It is a useful tool to evaluate the purity of water (Acharya *et al*; 2008). It is due to abundant dissolved salts, which comes in the water bodies through different source. Variations in the value of Electrical Conductivity have been reported by Kataria *et al*; (2011) and Srivastava and Kanungo

(2013), Dixit *et al*; (2015). Present observation is thus in agreement with the above workers.

CONCLUSION:

Monitoring of health of the Manika Lake water is essential as the water is being used by the people near it. Physico-chemical analysis of different parameters will suggests about the health of water. Some of the parameters can be managed by the administration body asking the locals not to dump their domestic wastes may be solid or liquid. The value of dissolved oxygen will suggests the suitability of Lake water for fisheries. Similarly, BOD and COD are of great importance. Therefore, regular physico-chemical analysis of Lake water is essential.

ACKNOWLEDGEMENTS:

The author is thankful to the Principal of M.D.D.M. College, B.R.A. Bihar University, Muzaffarpur, who provided necessary facilities to perform this work.

TABLE:

Showing monthly variations in selected Physico-chemical parameters of Manika Lake water at Muzaffarpur.

Months / Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp. (^{0}C)	10.0	18.0	26.0	29.0	33.0	36.0	34.0	30.0	28.0	27.0	23.0	14.0
pH	8.3	8.1	7.6	7.8	8.0	7.6	8.0	7.8	7.4	7.6	7.54	7.7
Turbidity (NTU)	52.0	53.0	46.0	49.0	56.0	54.0	47.0	46.0	42.0	38.0	40.0	47.0
Alkalinity (mg/l)	124.0	143.0	146.0	149.0	158.0	148.0	132.0	158.0	152.0	134.0	138.0	132.0
Hardness (mg/l)	136.0	118.0	122.0	152.0	154.0	146.0	158.0	144.0	131.0	138.0	148.0	139.0
Dissolved Oxygen	8.7	8.0	7.8	6.5	5.2	4.3	5.9	6.4	6.87	7.3	7.7	7.9
Biological oxygen Demand	3.45	4.38	3.50	3.72	3.18	3.14	3.12	3.26	2.65	2.70	2.0	3.40
Chemical Oxygen Demand	35.2	48.4	32.5	22.6	27.5	29.3	22.8	23.2	24.6	24.5	25.7	29.8
Potassium (mg/l)	3.6	4.3	4.6	4.4	4.3	3.2	3.4	3.7	3.8	3.7	3.2	3.4
Nitrate (mg/l)	0.22	0.35	0.32	0.41	0.32	0.30	0.26	0.22	0.21	0.23	0.22	0.21
Phosphate (mg/l)	0.14	0.26	0.32	0.21	0.15	0.14	0.19	0.26	0.22	0.42	0.20	0.24
EC (µS/cm)	270.62	278.45	250.15	248.62	280.18	315.44	455.20	510.18	560.36	470.15	405.24	310.62

REFERENCES:

Acharya G.D., Hathi M.V., Patel A.D., Parmar K.C. (2008): Chemical properties of ground water in Bhiloda Taluka Region, North Gujarat, India. *E-Journal of Chemistry* 5(4) : 792-796.

Ahangar JA, Saksena DN, Mir MH, Ahangar MA.(2012): Seasonal variations in physico-chemical characteristics of Ancharlake, Kashmir. *Int J. Adv Biol Res.* 3(2): 352-357.

Ali M., Salam A. and Hussain, M.Z. (1994): Effect of seasonal variations on physico-chemical parameters of Zaidi Fish Farm. *Punjab Univ. J. Zool*. 9: 53-58.

Ali Muhammad, Abdus Salam, Sumayya Iram, Tasveer Zahra Bokhari and Kamran Ali Qureshi (2005): Studies on monthly variations in biological and physico-chemical parameters of Brackish water fish pond, Muzaffargarh, Pakistan. *Journ. of Res. (Sci.),Bahauddin Zakariya Univ., Multan, Pakistan.* 16(1): 27-38.

APHA (American Public Health Association) (2005): Standards methods for the examination of water and waste water, 21st Edn- *American Public Health Association* Washington DC.

APHA (1995): Standard Methods for the Examination of Water and Wastewater. Washington, DC. 1-75.

Arivoli, S., Dhinamala, K., Persis, D., Meeran, M., &Pandeeswari, M. (2018). Analysis of physico-chemical water quality parameters of Buckingham Canal, Chennai, Tamil Nadu, India. *International Journal of Zoology Studies*, 3(1), 226–231

Baxa M., Musil M., Kummel M., Hanzlik, P., Tesarova, B, Pechar L (2020): Dissolved Oxygen deficit in a shallow eutrophic aquatic ecosystem (Fish- pond) sediment oxygen demand and water column respiration alternately drive the oxygen regime. *Sci. of the Total Environment.* 766: 142647.

Begum, A., Mondal, S., Ferdous, Z., Zafar, M. A., &Ali, M. M. (2014). Impact of water quality parameters on *Monosex tilapia* (*Oreochromis niloticus*) production under pond condition. *International Journal Animal Fish Science*, 2(1), 14–21.

Bhat, S. U., & Pandit, A. K. (2020). Water quality assessment and monitoring of Kashmir Himalayan fresh water. WATER SCIENCE 133springs-A case study. *Aquatic Ecosystem Health &Management*, 23(3), 274–287.

Bhatnagar, A., & Devi, P. (2013). Water quality guidelines for the management of pond fish culture. *International Journal of Environmental Sciences*, 3(6), 1980–2009.

Boyd, C.E. (1981): Water quality in Warm water fish ponds. Auburn University. 359 *Craftmaster Printers, Ine, Oplika, Alabama,* USA.

Cabral-Pinto, M., Inácio, M., Neves, O., Almeida, A. A.,Pinto, E., Oliveiros, B., & Ferreira da Silva, E. A. (2020).Human health risk assessment due to agricultural activities and crop consumption in the surroundings of an industrial area. *Exposure and Health*, 12(4), 629–640.

Cao, J., Sun, Q., Zhao, D., Xu, M., Shen, Q., Wang, D., &Ding, S. (2020). A critical review of the appearance of black-odorous water bodies in China and treatment methods. *Journal of Hazardous Materials*, 385, 121511.

Caquet T, Lagadic L, Monod G, Lacaze JC, and Coute A. (2001) Variability of physicochemical and biological parameters between replicated outdoor freshwater lentic mesocosms. *Ecotoxicol*. 10(1): 51-66.

Chaurasia M, and Pandey, GC. (2007) Study of physico-chemical characteristics of some water pond of Ayodhya-faizabad. *Indian J Environ Prot.*; 27(11):1019-1023.

Crosa, G., Castelli, E., Gentili, G., & Espa, P. (2010). Effects of suspended sediments from reservoir flushing on fish and macro invertebrates in an alpine stream. *Aquatic Sciences* 72(1), 85–95.

Dey, S., Botta, S., Kallam, R., Angadala, R., & Andugala, J.(2021). Seasonal variation in water quality parameters of Gudlavalleru Engineering College pond. *Current Research in Green and Sustainable Chemistry*, 4, 100058.

Dixit, A.K., S.K. Pandey, R. Mehta, Niyaz Ahmad Gunjan, Jyoti Pandey (2015): Study of physico-chemical parameters of different pond water of Bilaspur District, Chhattisgarh, India. *Environmental Skeptics and Critics*. 4(3): 89-95.

Dwivedi B.K. and Pandey G.C. (2002): Physico-chemical factors and algal diversity of two ponds (Girija Kund and Maqubara pond), Faizabad. *Poll. R.S.* 21: 361-370

Engwa, G. A., Ferdinand, P. U., Nwalo, F. N., & Unachukwu, M. N. (2019). Mechanism and health effectsof heavy metal toxicity in humans. *Poisoning in the Modern world-new Tricks for an Old Dog*, 10.

Gangwar, R. K., Singh, J., Singh, A. P., & Singh, D. P.(2013). Assessment of water quality index: A case study of river ramganga at Bareilly UP India. *International Journal of Scientific & Engineering Research*- 4(9), 2325–2329.

Halim A, Shamim S., Rahman H., Haque M., Rahman S., Islam S. (2018): Assessment of water quality parameters in boar environment, Bangladesh, A review. *Int. J. of Fisheries and Aquatic Studies*. 6(2): 269-279.

Harney, N. V., Dhamani, A. A., & Andrew, R. J. (2013). Seasonal variations in the physico-chemical parameters of pindavani pond of central India. *Weekly Science*, 1(6), 1–8.

Hassall, C. (2014). The ecology and biodiversity of urban ponds. Wiley Interdisciplinary Reviews: *Water*, 1(2), 187–206.

Hawes, I., Howard-Williams, C., & Sorrell, B. (2014). Decadal timescale variability in ecosystem properties in the ponds of the McMurdo Ice Shelf, southern Victoria Land, Antarctica. *Antarctic Science*, 26(3), 219–230

Hulyal, SB, and Kaliwal, BB.(2011) Seasonal variation in physico-chemical characteristics of Almatti Reservoir of Bijapur district, Karnataka state. *Int J Environ Proct.* 1(1): 58-67.

Islam, M. S., Nakagawa, K., Abdullah-Al-Mamun, M.,Siddique, M. A. B., & Berndtsson, R. (2022). Is road-side fishpond water in Bangladesh safe for human use? An assessment using water quality indices .*Environmental Challenges*, 6, 100434

Jayalakshmi, V., Lakshmi N. and Singaracharya M.A. (2011): Assessmetn of physico-chemical parameters of water and waste waters in and around Vijaywada. *Int. Journ. of Res. in Pharmaceut. And Biomed. Sci.* 2(3): 1040-1046.

Kataria HC, Gupta, MK, Kushwaha S, Kashyap S, Trivedi S, Bhadoriya R,

Bandewar NK. (2011). Study of physico-chemical parameters of drinking water of Bhopal city with Reference to Health Impacts. *Current World Environment,* 6(1): 95-99

Khan, A. A., Nabi, N. G., Dar, S. H., Rashid, A., Teli, A. R., &Bashir, M. (2017). Seasonal variations of physico-chemical parameters in lower lake of Bhopal. *The Pharma Innovation Journal*, 6(11), 710–714.

Khatri, N., & Tyagi, S. (2015). Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. *Frontiers in Life Science*, 8(1),23–39.

Kiran BR. (2010). Physico-chemical characteristics of Fish Ponds of Bhadra project at Karnataka, India. *Rasayan Journal of Chemistry*, 3(4): 671-676

Kraemer, B. M., Anneville, O., Chandra, S., Dix, M.,Kuusisto, E., Livingstone, D. M., & McIntyre, P. B.(2015). Morphometry and average temperature affect lake stratification responses to climate change. *Geophysical Research Letters*, 42(12), 4981–4988.

Kumar N., Singh N.P. (2013): Studies on the itchthyofauna of Karaia lake of Motihari, East Champaran, Bihar India. *Res. Journ. of Anim. Veten. and Fishery Sci.* 1(9): 8-12.

Kumar, A., Mishra, S., Taxak, A. K., Pandey, R., & Yu, Z. G.(2020). Nature rejuvenation: Long-term (1989–2016) short-term memory approach based appraisal of water quality of the upper part of Ganga river, India. *Environmental Technology & Innovation*, 20, 101164.

Kumar, R., & Saikia, P. (2020). Floristic analysis and dominance pattern of sal (*Shorea robusta*) forests in Ranchi, Jharkhand, eastern India. *Journal of Forestry Research*, 31(2), 415–427.

Kumar, R., & Saikia, P. (2021). Spatio-temporal soil nutrient dynamics and plant species diversity in selected Sal forests of

Ranchi, Eastern India. *Vegetos,* 34(1), 235–248.

Kumara, A., Sharmab, M. P., & Raic, S. P. (2017). A novel approach for river health assessment of Chambal using fuzzy modeling, India. *Desalination Publications,* 58(2017), 72–79.

Kumari, P., & Maiti, S. K. (2021). Bioaccessibilities and health risk assessment of heavy and trace elements in fish from an urban city, India. *Human and Ecological Risk Assessment: An International Journal,* 27(1), 50–70.

Kumari, P., Chowdhury, A., & Maiti, S. K. (2018). Assessment of heavy metal in the water, sediment, and two edible fish species of Jamshedpur Urban Agglomeration, India with special emphasis on human health risk. *Human and Ecological Risk Assessment*: An International Journal, 24(6), 1477–1500.

Kumari, S., Khan, J. A., & Lal Thakur, M. S. (2019). Study of physico-chemical characteristics of water and soil in relations to fish production in Motia lake reservoir. *Journal of Atmospheric & Earth Sciences,* 2(6), 1–9.

Kupoluyi, A. Y., Alarape, S. A., & Adeyemo, O. K. (2018). Impact of industrial effluents on Alaro river in Oluyole industrial estate, Ibadan and its suitability for aquatic life. *Sokoto Journal of Veterinary Sciences,* 16(1), 38–44.

Liu, Y., Yang, L., & Jiang, W. (2020). Coupling coordination and spatiotemporal dynamic evolution between social economy and water environmental quality–A case study from Nansi Lake catchment, China. *Ecological Indicators*,119, 106870.

Mahajan A, Tank SK. (2013). Studies on the physico-chemical parameters of water body- Dara Dam, Maharashtra, India. *International Journal of Innovative Research and Development,* 2(3): 751-759

Majumdar S. , Gupta S, Saha R.N., Datta J.K. and Mandal N. (2006): Eutrophication potential of municipal sewage of Burdwan town, West Bengal, India. *Pollut. Res.* 25(2): 299-302.

Manjare SA, Vhanalakar SA, Muley DV. (2010). Analysis of water quality using physico-chemical parameters tamdalge tank in kolhapur district, Maharashtra. *International Journal of Advanced Biotechnology and Research*,1(2): 115-119

Mahobe H., (2013): Study of physico-chemical characteristics of water ponds of Rajnand gaon town, Chhattisgarh. *USER*, 4(8), 738-748.

Mayer, E. (2012). Monitoring pond water quality to improve production. *Biomin*, June, 15, 2012

Mol PA, and Shaji E. (2016): Physico-chemical characteristics of surface water quality of urban ponds in Thiruvananthapuram District, Kerala. *Int J Emer Trend Sci Tech*. 3(1): 3431-3437.

Mukherjee P., P. Kumar, Shashi Kumar Gupta and Rahul Kumar (2022): Seasonal variation in physico-chemical parameters and suitability for various uses of Bouli pond water, Jharkhand. *Water Science* 36(1): 125-135.

Mushtaq, N., Singh, D. V., Bhat, R. A., Dervash, M. A., &Hameed, O. B. (2020). Freshwater contamination: Sources and hazards to aquatic biota. In Fresh water pollution dynamics and remediation (pp. 27–50).*Singapore: Springer*.

Naik S, and Purohit, KM.(1996): Physico-chemical analysis of some community pond of Rourkela. *Int J Environ Poll*, 16(9); 679-684.

Naik, T.P., Ajayan K.V., Lokesh G.H. (2012): Physico-chemical characteristics of Kunigal Lake in Tumkur District, Karnataka, India. *Int. J. of Chemical Sci.* 10(2): 655-663.

Nair, MS Rajendran,(2002): Seasonal variations of physicochemical factors and its impact on the ecology of a village pond at Imala, Vidisha. *J. Ecobiol.* 12(1):21-27.

Nandan S.N., Patel R.J.(1992): Ecological studies of algae in aquatic ecology (*New Delhi, Ashish Publishing House*)

Ni, M., Yuan, J. L., Liu, M., & Gu, Z. M. (2018). Assessment of water quality and phytoplankton community of Limpenaeus vannamei pond in intertidal zone of Hangzhou Bay, China. *Aquaculture Reports*, 11, 53–58

Nirmala, Nirmala, B, Kumar, S, Suchetan, P and Prakash, M.(2012): Seasonal variations of physico-chemical characteristics of general water samples of Mysore city, Karnataka, India. *Int. Res J Environ Sci*. 1(4): 43-49.

Nitesh Kumar Mehta and Arti Kumari (2022): Study of water quality using of physico-chemical parameters of two perennial fish ponds of Darbhanga. *Int. Journ. of Fisheries and Aquat. Stud*. 10(3): 128-132.

Ntengwe, F. W., & Edema, M. O. (2008). Physico-chemical and microbiological characteristics of water for fish production using small ponds. *Physics and Chemistry of the Earth, Parts A/B/C*, 33(8–13), 701–707.

O'Reilly, C. M., Sharma, S., Gray, D. K., Hampton, S. E.,Read, J. S., Rowley, R. J., & Zhang, G. (2015). Rapid and highly variable warming of lake surface waters around the globe. *Geophysical Research Letters*, 42(24), 10–773.

Othman, A., Dumitrescu, E., Andreescu, D., & Andreescu, S.(2018). Nanoporous sorbents for the removal and recovery of phosphorus from eutrophic waters: Sustainability challenges and solutions. *ACS Sustainable Chemistry &Engineering*, 6(10), 12542–12561.

Padma S, Periakali.(1999): Physicochemical and geochemical studies in Pulicat Lake, east coast of India. *Indian J. Mar. Sci.* 28:434-437.

Pal, S., & Chakraborty, K. (2017). Different aspects of chloride in freshwater: A review. *International Journal of Current Trends in Science and Technology*, 7(8),20295–20303.

Perumal, M., & Gopalsamy, S. (2020). Climatic variation in water quality assessment of selected temple ponds In Kanchipuram. *Executive Editor*, 11(7), 530

Prakash S, Verma AK, and Prakash S. (2015a): Limnological studies of Alwara Lake of Kaushambi (U.P.). *International Journal on Biological Sciences*. 6(2):141-144

Rani, S. (2019). Physico-chemical properties of fresh water fish pond in relation to fish farming in Darbhanga district. *Journal of Emerging Technologies and Innovative Research*, 6(6), 541–544.

Ranjan R., Srivastava S., Ramanathan A.L. (2017): An assessment of the hydrogeochemistry of two wetlands located in Bihar State in the subtropical climatic zone of India. *Environ Earth Sci*. 76: 16.

Rao KDS, Ramakrishniah M, Karthikeyan M, Sukumaran PK. (2003). Limnology and fish yield enhancement Reservoir (Cauvery River System). *Journal of Inland Fisheries Society of India*, 3(5): 20-27

Rout K.S, Shinde, S.E. Pathan T.S., Sonawane D.L. (2011): Seasonal variations in physico-chemical characteristics of Peth Lake at Ambajogai District, Marathwada Region, India. *J. of Res. In Biology* 1(4): 258-262.

S. Ramanathan, A. Amsath (2018): Seasonal variations in physico-chemical parameters of Puthukulam pond, Pudukkottai, Tamilnadu. *RJLBPCS* 4(6): 656-662.

Sachidanandamurthy K. L. and Yajurvedi H. N. (2004): Monthly variations in water quality parameters (physico-chemical) of a Perennial lake in Mysore city. *Indian Hydrobiol.* 7: 217-228.

Saha, A., Ramya, V. L., Jesna, P. K., Mol, S. S., Panikkar, P.,Vijaykumar, M. E., & Das, B. K. (2021). Evaluation of spatio-temporal changes in surface water quality and their suitability for designated uses, Mettur reservoir, India. *Natural Resources Research,* 30(2), 1367–1394.

Saha, S., Mandal, A., & Sahoo, D. (2017). Study of physico-chemical parameters of three different urban pond water of Nadia district, West-Bengal, India. *International Journal of Fisheries and Aquatic Studies*, 5(6), 23–27.

Sahni Kavita and Sheela Yadav (2012): Seasonal variations in Physico-chemical parameters of Bharawas Pond, Rewari, Haryana. *Asian J. Exp. Sci*. 26(1): 61-64.

Salam, A. and Mahmood, J.A. (1998): Studies on physico-chemical parameters of river system in Chitral Pakistan. *P.J. Zool. Abstract,* Series No. 18

Salamm, A. and Perveen, S. (1996): Seasonal changes in physico-chemical parameters of Dhand Ghazanfar Garh, Pakistan. *Acta Sci*. 6(1): 45-46.

Salomova, K. Y. (2021). Appearance of quality, quantity and norm categories in the medical thoughts of Avicenna. *Academic Research in Educational Sciences*, 2(1).

Sarkar, R., Ghosh, A. R., & Mondal, N. K. (2020). Comparative study on physicochemical status and diver-sity of macrophytes and zooplanktons of two urban ponds of Chandan nagar, WB, India. *Applied Water Science*, 10(2), 1–8.

Shah, MC, Shilpkar, PG, Parashar, A and Patiyal, RS.(2006): Seasonal variation in physic- chemical characteristics of Ranjit sagar reservoir, Jammu and Kashmir. *J Ecophysiol Occupat Healt.* 6: 1-5.

Sharma KK, Kour, S, and Sharma K. (2017): Seasonal variations in physico-chemical parameters of Dilli pond, sainik colony, J&K. *Int J Appl Res*. 3(7): 686-691.

Shrivastava S, Kanungo VK. (2013). Physico-Chemical Analysis of Pond Water of Surguja District, Chhattishgarh, India. *International Journal of Herbal Medicine,* 1(4): 35-43

Singh RP, Mathur P, (2005): Investigation of variations in physicochemical characteristics of a fresh water reservoir of Ajmer city, Rajesthan, *Ind. J. Environ. Science.* 9:57-61

Singh Rashmi, S. Nirajan and S. Nagar (2023): Study of physico-chemical parameters on a fresh water pond of Orai, U.P., India. *U.P. Journal of Zool*. 44(10): 83-93.

Sneha M. Sahu K.K. (2020): Physico-chemical analysis off ponds and river water in Darbhanga. *Int. J. of Creative Re. Thoughts*. 8(12): 1428-1444.

Stone, N. M., Shelton, J. L., Haggard, B. E., &Thomforde, H. K. (2013). Interpretation of water analysis reports for fish culture. *In SRAC Publication* (Vol. 4606,pp.1–12).

Teame, Tsegay and Zebib, Haftom (2016): Seasonal variation in physico-chemical parameters of Tekeze reservoir, Northern Ethiopia. *Animal Res. Int*. 13(2): 2413-2420.

Thirupathaiah M, Samatha CH, Chintha S. (2012). Analysis of water quality using physico-chemical parameters in lower manair reservoir of Karimnagar district, Andhra Pradesh. *International Journal of Environmental Sciences.* 3(1): 172-180

Trombadore, O., Nandi, I., & Shah, K. (2020). Effective data convergence, mapping, and pollution categorization of ghats at Ganga river front in Varanasi. *Environmental Science and Pollution Research*, 27(13), 15912–15924.

Valencia-Castañeda, G., Vanegas-Pérez, R. C., Frías-Espericueta, M. G., Chávez-Sánchez, M. C., Ramírez-Rochín, J., & Páez-Osuna, F. (2018). Comparison of four treatments to evaluate acute toxicity

of nitrite in shrimp *Litopenaeus vannamei* postlarvae: Influence of feeding and the renewal water. *Aquaculture*, 491,375–380.

Venkatesh AK, Agha L, Abaluck J, Rothenberg C, Kabrhel C, and Raja AS.(2018): Trends and variation in the utilization and diagnostic yield of chest imaging for medicare patients with suspected pulmonary embolism in the emergency department. *Am J Roentgenol*. 210(3), 572-577.

Verma PU, Purohit AR, Patel N J. (2012): Pollution Status of Chandlodia Lake Located in Ahmadabad Gujarat. *IJERA*. 2:1600-1606.

Wani I.A., Sulba, (1990): Physico-chemical features of two shallow Himalayan lakes. *Bull. Environ. Sci*. 8: 33-49.

Whitehead, P., Bussi, G., Hossain, M. A., Dolk, M.,Das, P., Comber, S., & Hossain, M. S. (2018).Restoring water quality in the polluted Turag-Tongi-Balu river system, Dhaka: Modeling nutrient and total coliform intervention strategies. *Science of the Total Environment*, 631, 223–232.