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A STUDY TO ACCESS THE PHYSIO-CHEMICAL PARAMETERS OF WATER QUALITY OF SELECTED PONDS FROM THREE DISTRICTS OF TAMIL NADU, INDIA

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ABSTRACT

Water is the most abundant and non-renewable resource in the earth, which play an important role in all living organisms. A study on physiochemical parameters of Manur, Vallanadu and Sundarapandiapatinam ponds from Tirunelveli, Thootukudi and Ramanathapuram districts of Tamil Nadu, India, has addressed the seasonal changes. During the month of January to April samples from Manur was chemically portable, Vallanadu sample was physically portable, Sundarapandiapatinam samples were physically and chemically not portable. During the month of May to August Vallanadu and Manur samples were portable by its physical and chemical examination, Sundarapandiapatinam samples were non portable by its physiochemical property. September to December the samples from all the three ponds were non portable because of exceeding the permissible limit. All the samples were bacteriologically unsafe in nature because of its microbial contamination. This implies the water bodies are not fit for domestic and drinking purpose, thus proper management has to be done by the society and implement government guidelines to save the natural resources from manmade activities.

***Keywords*:** Physico-chemical parameters, Manur, Vallanaduu, Sundarapandiapatinam

INTRODUCTION

Earth is the planet which accommodates 70% of water resources in its total area. Water is the major source for survival and growth of all living organism (Sarkar *et al.,* 2020). The availability of pure water is an indispensable for precluding disease and improving quality of life (Hamaidi-Chergui *et al.,* 2013).Reservoirs are constructed across the rivers in the form of dams, lakes, ponds etc. The reserved water can be reused for industrial practice, irrigation, navigation, domestic water supply, fish culture, recreation, hydroelectricity generation and during water crises (Loucks & Beek, 2017).

Ponds are used from the immemorial days for the reservoir in India for multipurpose, such as for irrigation, feeder for animals and domestic usage of humans during drought conditions. It plays a major role in aquatic ecosystem even its smaller in size when compare to lakes, dams etc, and comprises of more living organisms such as aquatic animals, birds and making a balanced ecosystem. Aquatic life depends mainly on the quality of water (Kumar *et al*., 2021). Biodiversity is essential for ecological balance and human surveillances in the earth (Verma, 2018). It is essential to conserve biodiversity (Verma, 2019), from the manmade activities climate changes (Prakash &Srivastava, 2019), to save the natural resources from destruction, pollutions for our future generations.

Enormous usage of resources by human population, industrialization, sewage addition, fertilizers in agriculture and other mam made activities has polluted the natural resource by waste disposal, pesticide or fertilizer accumulation and this becoming contaminated and harmful to the environment (Subba *et al.,* 2012). Fresh water need to have special attention to free from contamination and sustainable for the present and future generations.

Physio-chemical parameters are the important component in aquatic system to indicate water quality of aquatic ecosystem (Singh & Singh, 2008). Regular assessment of water quality is now become a critical factor for the conservation of aquatic resource and ecosystem. It should be a continuous process with periodic assessment for sustainability for agriculture, industries, aquaculture etc. Pollution in water is measured primarily by assessing the physiochemical parameters of water (Latha & Mohan, 2010).

The natural source of pollution and their impact on eco-biological environment can be assessed and remedies for polluted water bodies can be governed with physiochemical analysis. To solve the problems in water resources; quality

assessment in periodical manner, planning to maintain ecofriendly environment by implementing new government policies, self-addressing of problems and making solution by every individuals can help it. Therefore present study was conducted to evaluate the discrepancy in their water quality at different interval of time in selected ponds from Tirunelveli, Thootukudi and Ramanathapuram district.

MATERIALS AND METHODS

The water samples from the ponds were collected at the interval of four months (January - April, May - August and September- December) during the year of 2020. Our study was conducted on three ponds from three districts such as Manur of Tirunelveli district, Vallanadu of Thootukudi district and Sundarapandiapattinam of Ramanathapuram district of Tamil Nadu, India. Graphical study area of the location was shown in figure 1.

Physical parameters such as pH, temperature, conductivity were measured in the field condition. Chemical analysis nitrate, nitrite, chloride, were analysed by standard procedure described by American Public Health Association (APHA, 1998). Parameters such as dissolved oxygen, total alkalinity, hardness, sulphates and total dissolved solids etc were done by standard method in laboratory (APHA, 2005). Calcium and magnesium were analyzed by atomic absorption chromatography and sodium by flame photometry. The organic matter were determined by permanganate oxidation method (Wilson, 1959).

RESULT AND DISCUSSION

The water samples collected from three different districts of three different ponds showed varied in their results. The results obtained from the samples from same location at different interval of times showed inconsistency in their physical and chemical parameters. Results obtained based on physical parameters was tabulated in table 1.Appearance of the water sample from Manur, Vallanadu and S.P. Pattinam during the months from January to August showed clear in its nature in all the three locations, which implies the water samples were not contaminated. At the month of September to December the water sample from Manur, Vallanadu and S.P. Pattinam was turbid. The turbid nature showed presence of organic matters in the water, which can be added by different manmade activities such as pesticides, agriculture waste addition, pollution, etc.

The colour of the water was colourless in all the three sites during collection months January to August. This implies there were no contaminations or no addition of unwanted organic matters present much more in the study area. During September to December Manur and S.P. Pattinam samples was greenish and Valland sample was reddish in nature. The greenish nature of S.P. Pattinam sample may due to presence of algal flora. A review on assessment of water quality for monitoring the pollution on water by Nayar, (2020) also revealed the same.

The samples from Manur and S.P. Pattinam at the month of January to August was without any odour and there was no odour in the sample throughout the sampling time in Vallanadu. For the period of September to December Manur and S.P. Pattinam sample was algae odour. When the water bodies are rich in nutrient source such as nitrogen and phosphorous, the actinomycete proliferation and algal growth occurs, which turns the odour and taste of the water (Lin, 1977).

Turbidity of the water samples lower during the months of January to August and it gets increased during the months of September to December in all the three study area. Highest turbidity was noted in Vallanadu sample during the month of September to December when compared to other sampling area. This is because accumulation or presence of particles such as clay, organic matters, phytoplanktom or tiny organism (Purohit, 2002). Thus it may not fit for the usage of domestic purposes such as in food, beverages, pharma, fertilizer industries etc.

Total dissolved solids from three sampling locations showed varied in their results and highest TDS was noted in S.P. Pattinam sample of 9875mg/Lduring the month of September to December when compared with Manur and Vallanadu. This may occurred by the presence of suspended dissolved solids in the water bodies by manmade activities. A study on total dissolved solids in water bodies at Borgaon showed lowest of 347.16 mg/L and maximum of 738.0 mg/L (Alaka, 2014).

Electrical conductivity of the samples gradually increase and was higher during the month of September to December in both Manur and S.P. Pattinam, but samples from Vallanadu showed reversed manner by showing low conductivity during September to December and higher during January to April. Thus the conductivity of the water samples was not stable at all the times and it fluctuates. Similarly study made on three water samples from the ponds near Bhadrawati Town, Chandrapur District of Maharastra, India showed fluxuation from 611 and 4152 mho/cm (Kashyap, 2016).

Chemical parameters of the water showed varied in their observation based on different climatic conditions, environmental changes, pollutions, ecological imbalance etc. The results obtained was tabulated in table 2.In waters pH is controlled by balanced carbon dioxide, carbonate and bicarbonate ions and other natural occurring compounds such as humic and fluvic acids. The pH of the water samples from three location during the month of January to April and September to December was at acceptable range of 6.5-8.5.During the month of May to August pH range goes beyond the acceptable range of 9.44, 10.02, 9.65 in Manur, Vallanadu and S.P.Pattinam respectively. This implies the water is alkaline in nature. Similar findings was observed in water samples collected from Ganga River at Haridwar, which implies pH range of 7.06 to 8.35 (Joshi *et al.,* 2009). This changes in their pH indicates presence or addition of effluents from external environment. Results from literatures also revealed the same with continuously recording showed presence of effluent in the water body (Tessena *et al.,* 2014).

The alkalinity of the samples by their $CaCo_3$ $mg/_L$ content showed their availability are under the permissible limit of 600 mg/Lin both the locations of Manur and Vallanadu locations during the study period. The samples from S.P. Pattinam showed their range beyond the acceptable limit and within their permissible limit during January to August and beyond their permissible limit during September to December of 860 mg/L. During water level gets lowered the organic maters decay and this results Co_2released with addition of carbonate and bicarbonates. This increase in

alkalinity was due to conversion of insoluble carbonate to soluble bicarbonate (Narayana *et al.,* 2007).

Hardness of the samples was within their limit in Vallanadu sample during the study period and within their permissible limit in Manur. Similarly report on hardness of Kanhala pond, located in Chandrapur, Maharashtra, India, was also within the rage of 86.50 to 168.00 mg/L (Harney *et al.,* 2012). The results from S.P. Pattinam showed beyond their acceptable limit during our entire study period by fluxiation of 400-7000 mg/L. Hardness depends on calcium and magnesium salts but it does not affect human health.

Calcium content of the samples from Manur and Vallanadu are within their acceptable limit throughout our study period. The results obtained from S.P. Pattinam implies their contend was higher and beyond their permissible limits. The study made by Shani & Yadhav, (2012) reveals the calcium contend was high through weathering of rocks by leach out. Report by Nisbet & Verneau, (1970) states the calcium ranges 60 - 120 mg/L^{-1} are good for fishing water.

Magnesium contend of the samples are within their permissible limit in all the three locations during our study period except January to April 144 mg/L in S.P. Pattinam location. The concentrations present in our study area are below the range of calcium concentration. Our results are similar to the statement said by Venkatasubramani & Meenambal, (2007). Decrease in concentration of magnesium in the pond reduce the populations of phytoplankton.

Sodium present in the water has no significant effects on hardness, but beyond the permissible limits leads tasteless nature and unsuitable for irrigation. It also has a role in function of nervous system, membrane system, and excretory system. Sodium

Pottasium level in the water sample was acceptable in their limit during the month of January to April in Manur location, samples from other locations during our entire study was away from the acceptable range. Iron content present in the water sample at three different locations during our study period showed good results by acceptable range below 0.3 mg/L and the result implies from January to April of S.P. Pattinam showed beyond their permissible limit of 4.53 mg/L. This excess presence of metal in water bodies may lead to chronic disease towards aquatic animals. The presence of toxic metals in the aquatic environment will indirectly reaches human being by food chain, through absorbed water through irrigation, producers which are eaten by herbivores (Adnan, 2010).

Manganese present in the sampled locations during our study period are within the range of acceptable limit of the laboratory standard. Their availably increases when unwanted waste materials from animals or human activities entered into water bodies (Selvamohan *et al.,* 2014). Studies reveals presence of manganese in drinking water showed lower intellectual quotient in school aged children (Bouchard *et al.,* 2011). Higher concentration of manganese exposure leads to hyperactive behaviors (Bouchard *et al.,* 2007).

Ammonium content of the water samples from three locations during our study period was above the permissible limit. The ammonia level exceeds the permissible level in the water leads to death among fishes and other aquatic organisms.

Nitrate on the water sample from all the locations throughout our study period are within their acceptable limit. Nitrite present in our study locations showed acceptable limit during the month of January to April in Manur and S.P. Pattinam. Their range is beyond their permissible limit during remaining months in all the three locations. Nitrate and nitrite present in the source mainly due to direct or indirect contact with chemical fertilizer or sewage water waste on water bodies. This presence shows serious problems and toxic towards human beings and also environmental problems.

Chloride present in the samples were within their acceptable limit in all the three location during our study period. The samples from S.P. Pattinam showed beyond their permissible limit during our entire study. Chloride contend in the pond exceeds the permissible limit is due to contamination of organic waste (Selvamohan *et al.,* 2014). Higher concentration of chloride may lead to salty taste, corrode pipe lines, retard the growth of plants (Sajitha *et al.,* 2016), toxic against aquatic life (Rajkumar *et al.,* 2004).

Fluoride and Sulphate analysed for our study sample showed better results by showing the values within their acceptable limits in all the three sites during our entire study. Fluoride is essential for human at lower concentrations, at higher level it is toxic, permissible level is 0.6 to 1 mg/l. Higher amount of fluoride was 0.6 mg/L found in S.P. Pattinam during May to August. In the same way studies made on Deivanayagaperi pond of Cheranmahadevi, Tirunelveli District, Tamil Nadu, India, also reveals the results are within the acceptable range (Selvamohan *et al.,* 2014). In drinking water higher level of fluoride leads to degeneration of bones and dental mottling especially in pregnant women and children.

Phosphate content of the water samples from three locations are above the permissible limits throughout our study period. This implies the water got polluted by manmade activities. A study done by Jemi & Balasingh, (2011) on physico-chemical characteristics of fresh water temple ponds in Kanyakumari district, Tamil Nadu, India, reveals the phosphate value of 6.0mg/L as polluted water.

The water samples from all the locations during our entire study was bacteriologically contaminated with coliform, this implies the addition of agriculture waste, excreta, sewage addition directly connected to the pond water. Precaution to be taken to control man-made activities. The similar statement was stated by earlier researcher during his study on water quality (Mumtaz *et al.,* 2011).

CONCLUSION

The study made was a baseline against different ponds on three different districts, at different time durations, the result denotes they are variable in their physiochemical properties. The samples from Vallanaduis only portable by its physical and chemical properties during the month of May to August. The samples from other ponds in different months are non-portable by its chemical and physical parameters beyond their permissible limit. Among the samples S.P. Pattinam samples was most polluted and non-portable in their physiochemical property throughout our study. All the water samples was contaminated by bacteriological observation and are above the limit.

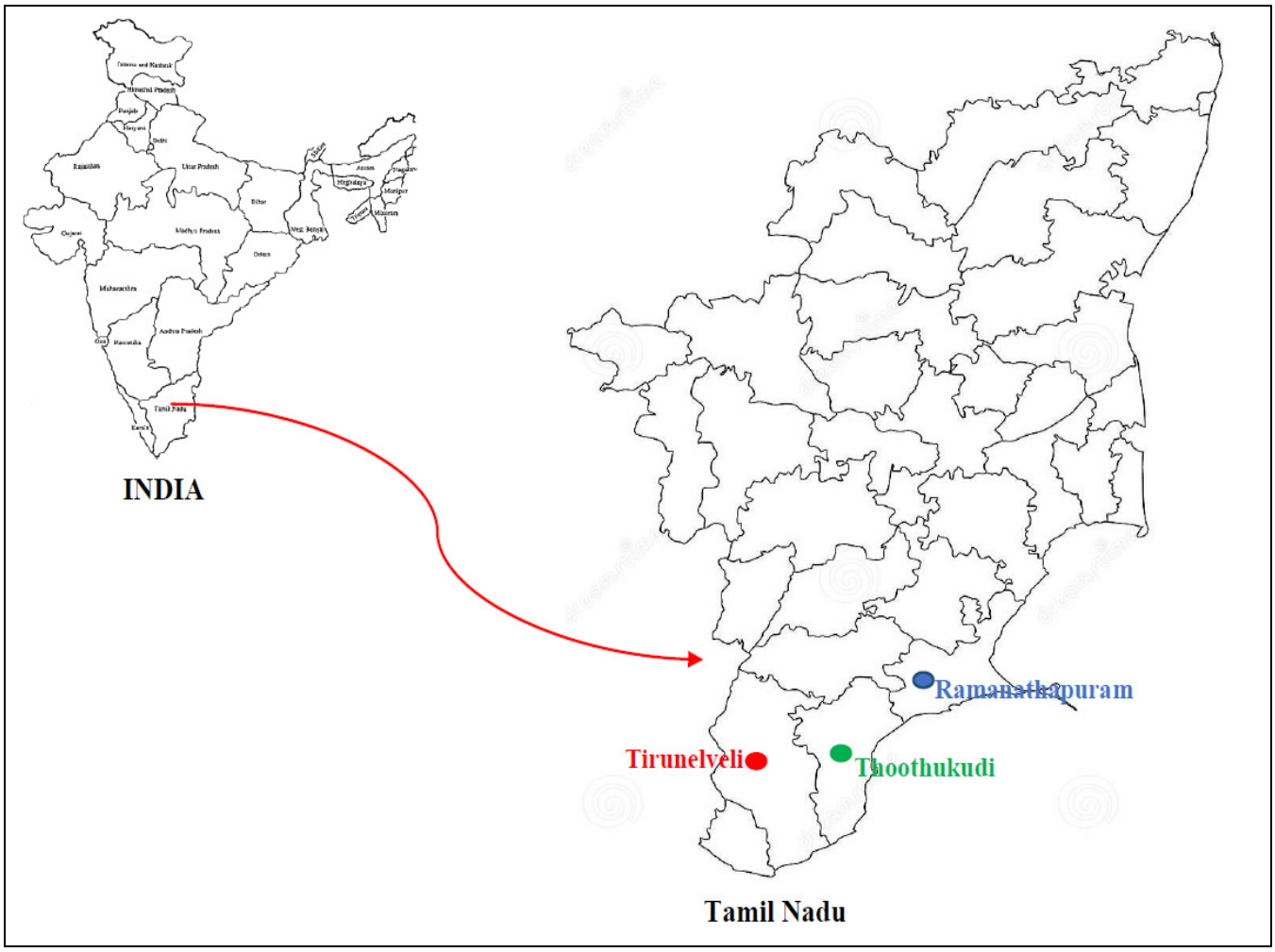

Fig. 1 : Graphical outline of our study area

Table 1 : Physical examination of water samples collected from different resources

Sl No	Test	Tirunelveli Manur (Jan-April 2020)	Tirunelveli Manur (May-Aug 2020)	Tirunelveli Manur (Sep-Dec 2020)	Toothukudi Vallanadu (Jan-April 2020)	Toothukudi Vallanadu (May-Aug 2020)	Toothukudi Vallanadu (Sep-Dec 2020)	Ramanad S.P. Pattinam (Jan-April 2020)	Ramanad S.P. Pattinam (May-Aug 2020)	Ramanad S.P. Pattinam (Sep-Dec 2020)
1	Appearance	Clear	Clear	Turbid	Clear	Clear	Turbid	Clear	Clear	Turbid
2	Color	Colourless	Colourless	Greenish	Colourless	Colourless	Reddish	Colourless	Colourless	Greenish
3	Odour	None	None	Algae odour	None	None	None	None	None	Algae odour
4	Turbidity	5	28	85	4	3	175	6	5	51
5	Total dissolved Solids mg/L	389	372	779	291	256	145	3927	3523	9875
6	Electrical conductivity Micro mho/cm	572	547	1145	428	376	213	5776	5181	14738

Table 2 : Chemical examination of water samples collected from different resources

Sl No	Parameters	AL	PL	Manur (TVL) (Jan-April 2020)	Manur (TVL) (May-Aug 2020)	Manur (TVL) (Sep-Dec 2021)	Vallanadu (TK) (Jan- April 2020)	Vallanadu (TK) (May-Aug 2020)	Vallanadu (TK) (Sep-Dec 2020)	S.P. Pattinam (RN) (Jan-Mar 2020)	S.P. Pattinam (RN) (May-Aug 2020)	S.P. Pattinam (RN) (Sep-Dec 2020)
1	pH	6.5-8.5	6.5-8.5	8.01	9.44	7.21	7.01	10.02	6.74	7.69	9.65	8.45
2	Total Alkalinity as $CaCo_3$ mg/$_L$	200	600	184	164	256	108	90	21	408	508	860
3	Total Hardness as $CaCo_3$ mg/$_L$	200	600	180	260	218	136	90	58	1500	400	7000
4	Calcium as Ca mg/L	75	200	45	37	66	35	24	15	360	104	1200
5	Magnesium as Mg mg/L	30	100	16	14	20	12	7	5	144	34	90
6	Sodium as Na mg/L	-	-	45	13	144	35	39	6201	570	873	300
7	Potassium as K mg/L	-	-	12	0	25	5	6	2	125	248	50
8	Iron as Fe mg/L	0.3	1	0.24	0	0	0.25	0	0	1.53	0	0
9	Manganese as Mn mg/L	0.1	0.3	-	-	-	-	-	-	-	-	-
10	Free Ammonia as NH_3 mg/L	0.5	0.5	0.32	0.96	3.20	0.64	0.96	14.72	0.80	0.96	3.52
11	Nitrite as NO_2 mg/L	-	-	0.00	0.12	0.24	0.29	0.10	0.39	0.00	0.9	0.03
12	Nitrate as NO_3 mg/L	45	45	2	6	4	2	3	6	0	1	3
13	Chloride as CL mg/L	250	1000	70	74	180	66	72	18	1700	1450	4650
14	Fluoride as F mg/L	1.0	1.5	0.1	0.3	0.5	0.2	.4	0.2	0.3	0.6	0.3
15	Sulphate as SO_4 mg/L	200	400	8	2	65	12	2	54	147	6	73
16	Phosphate as PO_4 mg/L	-	-	0.00	0.10	0.58	0.16	0.06	0.92	0.20	0.06	0.32
17	Tidys Test 4 hrs as O_2 mg/L	-	-	0.16	0.32	0.32	0.32	0.32	0.32	0.96	0.84	1.20

REFERENCES

Adnan, A.; Ahmad, T.; Ehsanullah, M.; Muhammad, I.; Khatak, M. and Khan, M.A. (2010). Evaluation of industrial and city effluent quality using physicochemical and biological parameters, *Electronic Journal of Environmental, Agricultural and Food Chemistry*, 9(5): 931-939

Alaka, P.A. (2014). An Assessment of Water Quality of Borgaon Reservoir in Sangli District of Maharashtra, India. *International Research Journal of Environment Sciences* 3: 48-53.

APHA, (1998). Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington, DC, USA, 18th edition.

APHA. (2005). Standard methods of examination of water and waste water. American public health association. 19th ed. Inc. New York: 1170.

Bouchard, M.F.; Sauve, S.; Barbeau, B.; Legrand, M.; Brodeur, M.-E.; Bouffard, T.; Limoges, E.; Bellinger, D.C. and Mergler, D. (2011). Intellectual impairment in school-age children exposed to manganese from drinking water. *Environmental Health Perspectives*. 119: 138-143.

Bouchard, M; Laforest, F; Vandelac, L; Bellinger, D; Mergler, D; (2007). Hair manganese and hyperactive behaviors: pilot study of school-age children exposed through tap water. *Environmental Health Perspectives*. 115:122-127.

Hamaidi-Chergui, F; Errahmani, M.B; Benouaklil, F; Hamaidi, M.S; (2013). Preliminary Study on Physico-

Chemical Parameters and Phytoplankton of Chiffa River (Blida, Algeria). *Journal of ecosystems*. 148793.

Harney, N.V; Dhamani, A.A and Andrew, R.J. (2012). Phycio-chemical status of three water bodies near Bhadrawati Town, Distt. Chandrapur, (M. S), India. Bionano Frontier. Eco Revolution, Colombo, Srilanka.

Jemi, R.J. and Regini-Balasingh, G.S. (2011). Studies on physico-chemical characteristics of freshwater temple ponds in Kanyakumari district (south Tamilnadu). *International Journal of Geology, Earth and Environmental Sciences.* 1:1; 59-62

Joshi, D.M; Kumar, A. and Agrawal, N. (2009) Studies on physicochemical parameters to assess the water quality of river Ganga for drinking purpose in Haridwar district. *Rasayan Journal of Chemistry*. 2: 195-203.

Kashyap, V.R. (2016). Physico-chemical analysis of various water samples of Rewa district (M.P.) India. *International Journal of Applied Research* 2: 311-313.

Kumar, S; Jain, V. and Raghuvanshi, S.K. (2021). Physico-chemical characteristics of Akshar Vihar pond in Bareilly, U.P. *International Journal of Advanced Research in Biological Science*. 8(3): 30-36.

Latha, N. and Ramachandra-Mohan, M. (2010). Water quality of the lake Kommaghatta, Bangalore. *Environment and Ecology*. 28 (3A): 1901-1905.

Lin, S.D. (1977). Tastes and odors in water supplies: a review. War. Sewage Wks 124, RI41 R142 and RI46-R163

Loucks, D.P. and Beek, E.V. (2017). Water Resources Planning and Management: An Overview. In: Water Resource Systems Planning and Management. Springer, Chem. 1-9.

Mumtaz, M.W.; Adnan, A.; Mukhtar, H.; Nawaz, K.; Raz, A. and Ahmad, Z; (2011). Estimation of bacteriological levels in surface water samples to evaluate their contamination profile. *Environmental Monitoring and Assessment.* 172: 581-587.

Narayan, R.; Saxena, K.K. and Chauhan, S. (2007). Limnological investigation of Texi temple pond in district Etawah (U.P.). *Journal of Environmental Biology*, 28(1): 155-157.

Nayer, R. (2020). Assessment of Water Quality Index and Monitoring of Pollutants by Physico-Chemical Analysis in Water Bodies: A Review. *International Journal of Engineering Research & Technology*. 9: 178-185.

Nisbet, M. and Verneau, J. (1970). Composantes chimiques des eaux courantes. *Annales de Limnologie.* 6: 161-190.

Prakash, S. and Srivastava S. (2019). Impact of Climate change on Biodiversity: An Overview. *International Journal of Biological Innovations*. 1(2): 60-65.

Purohit, S.S. (2002). Microbiology: Fundamentals and Applications. 6th ed; Agrobios Publishers. 439-443.

Rajkumar, S.; Velmurugan, P.; Shanthi, K.; Ayyasamy, P.M. and Lakshmanaperumalasamy, P. (2004). Water quality of Kodaikanal lake, in Tamilnadu in Relation to Physico-Chemical and Bacteriological Characteristics, pp. 339-346, Capital Publishing Company, Lake.

Sajitha, V. and Vijayamma, S.A. (2016). Study of Physico-Chemical Parameters and Pond Water Quality Assessment by using Water Quality Index at Athiyannoor Panchayath, Kerala, India. *Emergent Life Sciences Research,* 2(1): 46-51.

Sarkar, R.; Ghosh, A.R. and Mondal, N.K. (2020). Comparative study on physicochemical status and diversity of macrophytes and zooplanktons of two urban ponds of Chandannagar, WB, India. *Applied Water Science*. 10: 63.

Selvamohan, T.; Karthick, G.; Ramya, M.; Sarojini, V.; Sedhu, V. and Seetha, G. (2014). Studies on physicochemical characters of four ponds in Tirunelveli district. *Journal of Bio Innovation*. 3(4): 197-205.

Singh, D.K. and Singh, I. (2008). Interrelationship of certain physico-chemical parameters with plankton community of Motipur Ox-bow lakes (Muzaffarpur, Bihar). *Environment and Ecology*. 26: 800-803.

Subba, R.M.V.; Dhilleswara, R.V. and Bethapudi, S.A.A. (2012). Assessment of quality of drinking water at Srikurmam in Srikakulam district, Andhra Pradesh, India. *International Research Journal of Environment Sciences*, 1: 13-20.

Tessena, A.; Mohammed, A.; Birhanu, T. and Negu, T. (2014). Assessment of Physico-chemical Water Quality of Bira Dam, Bati Wereda, Amhara Region, Ethiopia. *Journal of Aquaculture Research and Development*. 5: 267.

Venkatasubramani, R. and Meenambal, T. (2007). Study of subsurface water quality in mattupalayam Taluk of Coimbatore district Tamil Nadu. *Nature Environment and Pollution Technology*. 6: 307- 310.

Verma, A.K. (2018). Ecological Balance: An Indispensable Need for Human Survival. *Journal of Experimental Zoology India*. 21 (1): 407-409.

Verma, A.K. (2019). Studies of Hydrobiological Properties of Balapur Pond of Prayagraj (U.P.). Hortflora. *Research Spectrum*. 8(1): 9-11.

Wilson, A.L. (1959). Determination of organic matter in water by oxidation with potassium permanganate. *Journal of Applied Chemistry*. 9: 51.