

ASSESSMENT OF WATER QUALITY INDEX OF LOKTAK LAKE

Comment [U1]: Application of WQI for Loktak Lake

ABSTRACT

Water quality is a significant contributor touching all aspects of ecosystem and human wellbeing and an important tool in determining the human poverty, wealth and education levels. It is vital and important to test the water before it is used for drinking, domestic, agricultural or industrial purpose. Loktak lake is the major freshwater wetland of Manipur and declared a Ramsar site in 1990. The aim of this study was to check the water quality status of Loktak lake. The results showed that maximum pH was 7.58 recorded at Sendra and the minimum pH was 7.10 recorded at Phubala. Maximum EC was 173 recorded at Komlakhong and the minimum was 99 recorded at Phubala. The DO was recorded maximum at Ningthoukhong with 7.9 and minimum was 6.2 recorded at Mayang Imphal. The maximum BOD was 2.7 recorded at Mayang Imphal and the minimum was 1.9 recorded at Ningthoukhong. The maximum Total Hardness was 50 recorded at Komlakhong and the minimum was 30 recorded at Phubala. The maximum Total Alkalinity was 78 recorded at Komlakhong and the minimum was 50 recorded at Phubala. The maximum Acidity was 20.1 recorded at Komlakhong and the minimum was 12.5 recorded at Phubala. The maximum Chloride was 11.36 recorded at Mayang Imphal and the minimum was 6.10 at Phubala. The maximum TDS was 68 at Mayang Imphal and the minimum was 33 recorded at Phubala. The maximum Sulphate was 31 recorded at Sendra and the minimum was 18 recorded at Phubala. The maximum COD was 26 recorded at Mayang Imphal and the minimum was 7 recorded at Ningthoukhong and Mayang Imphal. The present study revealed that most of the parameters are within the permissible limit when compared with BIS/WHO/ICMR. The value of water quality index were good as per the National Sanitation Foundation Water Quality Index.

Comment [U2]: Please mention the methodology of the study such as time duration, parameters measured and method of water quality analysis,

Comment [U3]: Please change the way presenting data

Comment [U4]: Mention the WQI value

Keyword

DO, BOD, Ecosystem, Parameters, Permissible, Ramsar, Water Quality Index,

INTRODUCTION

Water pollution affects drinking water, rivers, lakes and oceans all over the world, which consequently harms human health and the natural environment. Water pollution include sewage and waste water, industrial waste, oil pollution, marine dumping, atmospheric

deposition, radioactive waste, underground storage leakages, global warming, eutrophication etc. (Taruna and Alankrita, 2013).

Rapid industrialization, growing urbanization and significant factors are responsible for numerous forms of pollution of water bodies (Rajivet *al.*, 2017). Water quality is defined in terms of the chemical, physical and biological contents of water. The water quality of rivers and lakes changes with the seasons and geographic areas, even when there is no pollution present. Water quality guidelines provide basic scientific information about water quality parameters and ecologically relevant toxicological threshold values to protect specific water uses. Important physical and chemical parameters influencing the aquatic environment are temperature, rainfall, pH, salinity, dissolved oxygen and carbon dioxide. Others are total suspended and dissolved solid, total alkalinity and acidity and heavy metal contaminates. (Lawson, 2011).

Water pollution affects drinking water, rivers, lakes and oceans all over the world, which consequently problems human health and the natural environment. Water pollution include sewage and waste water, industrial waste, oil pollution, marine discarding, atmospheric deposition, radioactive waste, underground storage leakages, global warming, eutrophication etc. (Taruna *et al.*, 2013). Loktak lake is the major freshwater wetland of Manipur and declared a Ramsar site in 1990. A large number of people living in these communities utilized the water of the lake for drinking and other domestic purpose. (Jogeshet *al.*, 2014). Municipal waste, agricultural fertilizers, pesticides, bathing, wash, of cloths and utensils make the Lake polluted. (Prabhat, 2014). It is essential and important to test the water before it is used for drinking, domestic, agricultural or industrial purpose. Selection of parameters for testing of water solely depends on the purpose of utilization and the extent of its quality and purity. (Patilet *al.*, 2012).

MATERIAL AND METHODS

Loktak Lake is located in Bishnupur district of Manipur covering an area of 246.72 km² (National Wetland Atlas, 2009). The lake lies between 93° 46' –93° 55'E and 24° 25' – 24° 42' N of Manipur. Five seasons are distinct in the state viz; Summer (May-June), Rainy (Monsoon) (July-Sept), Autumn (Oct.-Nov), Cold winter (Dec.-Feb) and Spring (March-April). Since the onset, duration and amount of precipitation of the monsoon rain are erratic. Annual rainfall is sometimes as low as 975 mm and sometimes as high as 2,646 mm. Average relative humidity is between 36% and 100%.

Comment [U5]: Please explain more the novelty of the study

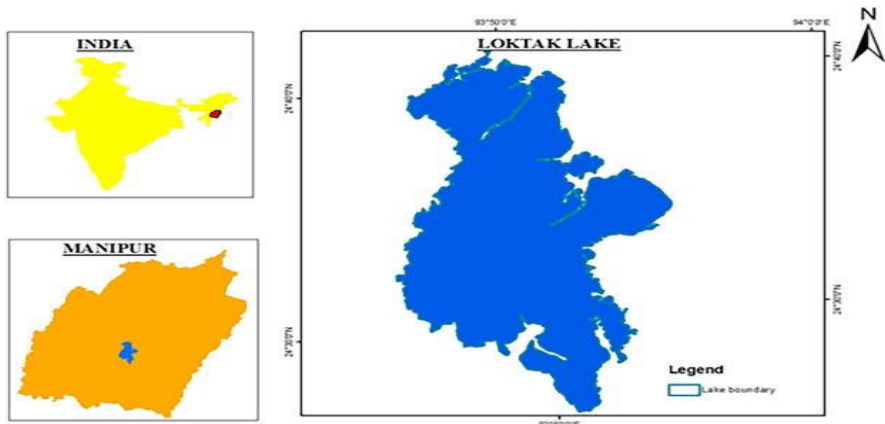


Fig. 1. Study Area

The samples were collected from different five areas of Loktak Lake, Manipur for a period of three months (January-March 2021) and three samples collected each site of each month. The five selected areas are Ningthoukhong, Phubala, Sendra, Mayang Imphal and Komlakhong. The samples were collected from the sub surface of the lake and ~~some of the water quality~~ parameters ~~like namely~~ DO, pH, EC, Transparency were measured at the spot. Analysis of the samples for physicochemical parameters was carried out in the laboratory of Manipur Pollution Control Board according to the prescribed guidelines.

Comment [U6]: Random sampling?

Comment [U7]: Please use the long name of the parameter when you use it first time

Comment [U8]: Please mention the equation of the WQI calculation?

Comment [U9]: Did you standards method to analysis of water quality parameters? What is that?

RESULTS

The results are based on the data collected during the experimental investigation of the study and are presented through subjective analysis and tables. Discussions are made for elaborating the interpretation of the results. The chemical characteristics of the water sample from the different sites of Loktak Lake at Manipur has been collected and analyzed twice a month (January –March 2021). The different parameters include pH, EC, DO, BOD, Acidity, Alkalinity, Hardness, Chloride, TDS, Sulphate and COD.

Comment [U10]: Where is the discussion part? You need to discuss your results after the mentioning the results. Include results within the prescribed guidelines or not?

Comment [U11]: Please mention the table number

Comment [U12]: Please use the long name of the parameter when you use it first time

The maximum value of pH for January was 7.4 at Komlakhong whereas the minimum value was 7.1 recorded at Phubala. The maximum value of pH for February was 7.35 at Komlakhong and the minimum value was 7.27 recorded at Phubala. The maximum value of pH for March was 7.35 at Komlakhong whereas the minimum value was 7.27 recorded at Phubala. The maximum value of pH for April was 7.46 at Mayang Imphal whereas the

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minimum value was 7.25 recorded at Phubala. The maximum value of pH for May was 7.58 at Sendra whereas the minimum value was 7.25 recorded at Phubala. The maximum value of pH for June was 7.48 at Sendra whereas the minimum value was 7.26 recorded at Mayang Imphal. It is important to check the pH water since it affects the solubility and availability of nutrient and its utility by aquatic organisms (Rajivet *et al.*, 2017).

The maximum value of EC for January was 173 at Komlakhong whereas the minimum value was 93 recorded at Phubala. The maximum value of EC for February was 160 at Komlakhong and the minimum value was 90 recorded at Phubala. The maximum value of EC for March was 160 at Ningthoukhong whereas the minimum value was 90 recorded at Phubala. The maximum value of EC for April was 160 at Mayang Imphal and Komlakhong whereas the minimum value was 110 recorded at Phubala. The maximum value of EC for May was 160 at Mayang Imphal whereas the minimum value was 100 recorded at Phubala. The maximum value of EC for June was 156 at Ningthoukhong and Komlakhong whereas the minimum value was 106 recorded at Mayang Imphal. Salinity is determined by measuring the ability of water to conduct an electric current. (Abbas, 2013).

Comment [U14]: Please mention the unit of the water quality parameter after its value

The maximum value of DO for January was 7.9 mg/L at Sendra whereas the minimum value was 6.3 recorded at Komlakhong. The maximum value of DO for February was 7.9 at Komlakhong and the minimum value was 6.9 recorded at Mayang Imphal. The maximum value of DO for March was 7.5 at Komlakhong whereas the minimum value was 7.2 recorded at Mayang Imphal. The maximum value of DO for April was 7.7 at Komlakhong and whereas the minimum value was 6.7 recorded at Sendra. The maximum value of DO for May was 7.9 at Komlakhong whereas the minimum value was 6.7 recorded at Mayang Imphal. The maximum value of DO for June was 7.9 at Phubala whereas the minimum value was 7.4 recorded at Sendra. High DO concentration during winter may be due to low temperature rather than the photosynthesis activity of the phytoplankton because low temperature has a greater capacity to hold DO than warm water. (Jogeshet *et al.*, 2014).

Comment [U15]: Please mention the unit of the water quality parameter after its value

The maximum value of BOD for January was 2.5 at Ningthoukhong whereas the minimum value was 1.9 recorded at Komlakhong. The maximum value of BOD for February was 2.5 at Phubala and the minimum value was 1.9 recorded at Ningthoukhong. The maximum value of BOD for March was 2.5 at Komlakhong whereas the minimum value was 2.1 recorded at Ningthoukhong. The maximum value of BOD for April was 2.6 at Phubala and whereas the

minimum value was 2 recorded at Ningthoukhong. The maximum value of BOD for May was 2.5 at Sendra whereas the minimum value was 2 recorded at Komlakhong. The maximum value of BOD for June was 2.3 at Sendra whereas the minimum value was 2 recorded at Phubala. The presence of BOD in natural surface of the water bodies of Loktak Lake may be polluted from the rivers mainly from the Nambul river and also from the domestic waste from local area including from several huts lying inside the lake on the phumdis. (Jogeshet *et al.*, 2014).

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The maximum value of Total Hardness for January was 50 at Komlakhong whereas the minimum value was 36 recorded at Phubala. The maximum value of Total Hardness for February was 48 at Komlakhong and the minimum value was 38 recorded at Phubala. The maximum value of Total Hardness for March was 49 at Komlakhong whereas the minimum value was 38 recorded at Phubala. The maximum value of Total Hardness for April was 44 at Mayang Imphal whereas the minimum value was 36 recorded at Phubala. The maximum value of Total Hardness for May was 44 at Ningthoukhong and Komlakhong whereas the minimum value was 36 recorded at Sendra. The maximum value of Total Hardness for June was 46 at Komlakhong whereas the minimum value was 37 recorded at Sendra. (Ritabrata *et al.*, 2019) reported Total Hardness tended to increase in winter and decrease in monsoon.

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The maximum value of Total Alkalinity for January was 73 at Komlakhong whereas the minimum value was 51 recorded at Phubala. The maximum value of Total Alkalinity for February was 78 at Komlakhong and the minimum value was 50 recorded at Phubala. The maximum value of Total Alkalinity for March was 75 at Komlakhong whereas the minimum value was 54 recorded at Phubala. The maximum value of Total Alkalinity for April was 75 at Mayang Imphal and whereas the minimum value was 58 recorded at Phubala. The maximum value of Total Alkalinity for May was 75 at Komlakhong whereas the minimum value was 53 recorded at Phubala. The maximum value of Total Alkalinity for June was 71 at Komlakhong whereas the minimum value was 63 recorded at Sendra. Higher Alkalinity was possible due to greater human activities including washing and bathing. (Sarita *et al.*, 2019)

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The maximum value of Acidity for January was 19 at Mayang Imphal and Komlakhong whereas the minimum value was 15 recorded at Phubala. The maximum value of Acidity for February was 20 at Komlakhong and the minimum value was 12.5 recorded at Phubala. The maximum value of Acidity for March was 20 at Sendra whereas the minimum value was 15 recorded at Phubala and Mayang Imphal. The maximum value of Acidity for April was 19.1

at Ningthoukhong and Komlakhong and whereas the minimum value was 13.3 recorded at Phubala. The maximum value of Acidity for May was 19 at Sendra whereas the minimum value was 16.6 recorded at Phubala. The maximum value of Acidity for June was 19.9 at Mayang Imphal whereas the minimum value was 14 recorded at Phubala. Acidity may be contained the lake is due to carry on different rivers to pass the city of Manipur and joint the lake at the end.

The maximum value of Chloride for January was 10.80 at Sendra whereas the minimum value was 6.10 recorded at Phubala. The maximum value of Chloride for February was 11.36 at Sendra and the minimum value was 7.10 recorded at Phubala. The maximum value of Chloride for March was 9.93 at Sendra whereas the minimum value was 6.10 recorded at Phubala and Mayang Imphal. The maximum value of Chloride for April was 10.80 at Sendra whereas the minimum value was 8.10 recorded at Phubala. The maximum value of Chloride for May was 18.88 at Sendra whereas the minimum value was 7.10 recorded at Phubala. The maximum value of Chloride for June was 9.94 at Ningthoukhong whereas the minimum value was 7.10 recorded at Mayang Imphal. High chloride content may indicate pollution by sewage or industrial wastes. (Arivola *et al.*, 2016)

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The maximum value of TDS for January was 64 at Komlakhong whereas the minimum value was 34 recorded at Phubala. The maximum value of TDS for February was 65 at Komlakhong and the minimum value was 33 recorded at Phubala. The maximum value of TDS for March was 65 at Komlakhong whereas the minimum value was 35 recorded at Phubala. The maximum value of TDS for April was 66 at Mayang Imphal whereas the minimum value was 44 recorded at Phubala. The maximum value of TDS for May was 68 at Mayang Imphal whereas the minimum value was 41 recorded at Phubala. The maximum value of TDS for June was 65 at Mayang Imphal whereas the minimum value was 40 recorded at Phubala. Among the different site the highest value was at Ningthoukhong and Mayang Imphal. (Ritabrata *et al.*, 2019). Reported TDS increase in summer and winter and decreased in spring and post-monsoon. In summer and winter, water level drops due to increased evaporation and decreased inflow. In decreased water volume the solutes get concentrated, so TDS increased.

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The maximum value of Sulphate for January was 28 at Sendra whereas the minimum value was 23 recorded at Phubala. The maximum value of Sulphate for February was 27 at Sendra

and the minimum value was 18 recorded at Phubala. The maximum value of Sulphate for March was 28 at Sendra whereas the minimum value was 23 recorded at Phubala. The maximum value of Sulphate for April was 27 at Mayang Imphal and whereas the minimum value was 23 recorded at Phubala. The maximum value of Sulphate for May was 28 at Ningthoukhong and Komlakhong whereas the minimum value was 22 recorded at Phubala. The maximum value of Sulphate for June was 26 at Komlakhong whereas the minimum value was 19 recorded at Phubala. (Rajiv *et al.*, 2017) found concentration of sulphate were low during monsoon and higher during ~~pre-monsoon~~pre-monsoon.

The maximum value of COD for January was 26 at Mayang Imphal whereas the minimum value was 9 recorded at Komlakhong. The maximum value of COD for February was 21 at Ningthoukhong and Sendra and the minimum value was 8 recorded at Komlakhong. The maximum value of COD for March was 22 at Sendra whereas the minimum value was 8 recorded at Komlakhong. The maximum value of COD for April was 24 at Sendra and Mayang Imphal whereas the minimum value was 7 recorded at Ningthoukhong. The maximum value of COD for May was 24 at Komlakhong whereas the minimum value was 7 recorded at Mayang Imphal. The maximum value of COD for June was 23 at Sendra whereas the minimum value was 8 recorded at Mayang Imphal.

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The value of water quality index were good as per the National Sanitation Foundation Water Quality Index. The maximum value of WQI was 78 at Sendra and the minimum value was 65 at Mayang Imphal. According to NSF WQI these values gives good and medium water quality status.

Table 1: Physicochemical Parameters of different sites of Loktak Lake

Sl. No	Parameter	Months	Ningthoukhong (S1)	Phubala (S2)	SendraS (3)	Mayang Imphal (S4)	Komlakhong (S5)
1.	pH	January	7.36	7.10*	7.45	7.33	7.49
		February	7.45	7.37	7.43	7.39	7.48
		March	7.33	7.27	7.32	7.28	7.35
		April	7.36	7.25	7.38	7.46	7.37
		May	7.37	7.25	7.58**	7.38	7.43
		June	7.34	7.27	7.48	7.26	7.47
	EC	January	156	93*	136	143	173**

		February	146	90	140	130	160
		March	160	90	143	130	156
		April	130	110	140	160	160
		May	130	100	136	160	150
		June	156	106	146	146	156
3	DO	January	7.8	7.6	7.9**	7.4	6.3
		February	7.4	7.7	7.5	6.9	7.9
		March	7.3	7.4	7.3	7.2	7.5
		April	7.6	7.2	6.7	7.6	7.7
		May	7.7	7.5	7.8	6.7	7.9
		June	7.8	7.9	6.2*	7.5	7.6
4	BOD	January	2.5	2.4	2.2	2.3	1.9
		February	1.9*	2.5	2.3	2	2.4
		March	2.1	2.3	2.4	2.4	2.5
		April	2	2.6	2.1	2.5	2.3
		May	2.3	2.2	2.5	2.1	2
		June	2.2	2	2.3	2.2	2.7**
5	Total hardness	January	41	36	40	38	50*
		February	40	38	42	40	48
		March	42	38	43	41	49
		April	38	36	38	44	42
		May	44	37	36	39	44
		June	39	40	37	43	46
6	Alkalinity	January	68	51	65	71	73
		February	71	50*	71	68	78**
		March	72	54	70	73	75
		April	70	58	72	75	70
		May	70	53	61	72	75
		June	68	66	63	70	71
7	Acidity	January	18.0	15.0	18.0	19.0	19.0
		February	20.0	12.5*	19.1	18.3	20.1**
		March	17.5	15.0	20.0	15.0	17.5

		April	19.1	13.3	16.6	17.5	19.1
		May	18.0	16.6	19.0	18.9	18.0
		June	16.6	14.0	17.5	19.9	18.0
8	Chloride	January	7.60	6.10	10.80	7.60	8.10
		February	8.52	7.10	11.36**	8.85	10.80
		March	7.50	6.10*	9.93	7.50	7.50
		April	9.40	8.10	10.80	10.4	8.52
		May	8.52	7.10	10.88	8.52	7.57
		June	9.94	8.52	9.46	7.10	7.57
9	TDS	January	60	34	55	58	64
		February	63	33*	56	57	65
		March	59	35	55	59	65
		April	57	44	57	66	64
		May	61	41	53	68**	62
		June	61	40	51	65	63
10	Sulphate	January	27	23	28	24	25
		February	24	18*	27	23	25
		March	27	23	28	24	24
		April	26	25	26	27	26
		May	28	22	27	25	28
		June	25	19	24	23	26
11	COD	January	16	13	24	26**	9
		February	21	16	21	16	8
		March	16	18	22	18	8
		April	7*	16	24	24	16
		May	8	17	13	7	24
		June	20	16	23	8	13

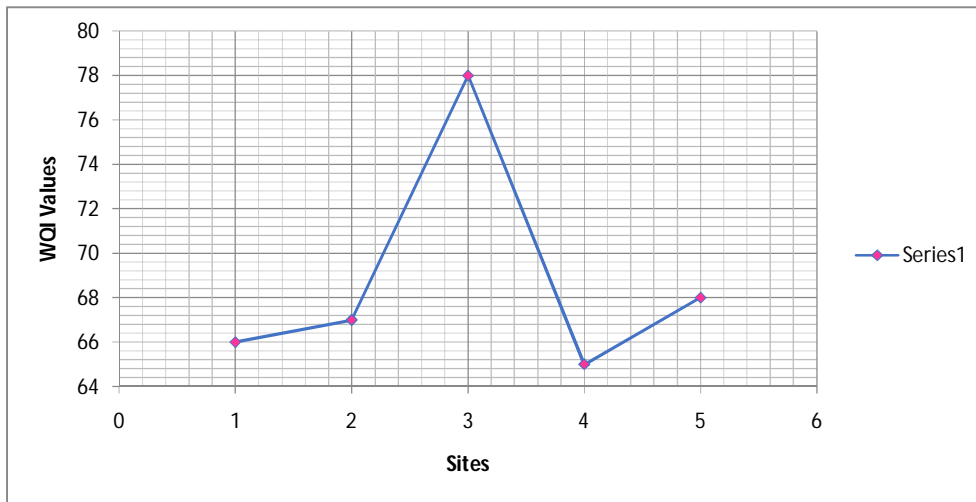


Fig 2. Graphical representation of WQI of different sites of Loktak Lake

Comment [U23]: Legend is series or WQI

CONCLUSION

Loktak lake acts as a natural reservoir for rivers and streams of the valleys and hills of Manipur. The results of the analysis of the different parameters of Loktak lake revealed that most of the values are within the permissible limit when compared with BIS/WHO/ICMR except for DO and COD where the values are slightly higher than the permissible limit. The higher values of DO is not a case of concern since it indicates a high amount of oxygen content in the water which is the most important requirement of the aquatic organisms, therefore higher the DO better is the water quality but high COD on the other hand is a case of concern since there will be greater demand for oxygen. The results obtained from WQI of the different sites indicate that the water at most of the sites comes in medium category which is not much polluted. It is also the largest freshwater inland natural reservoir in the eastern region of the country and has been identified as a major Indian Wetland by the World Conservation Union (IUCN) therefore proper monitoring is necessary for proper maintenance of its natural quality and beauty as the lake becomes more polluted day by day with the increase in population, increase in pollution from various industries, urbanization, industrial effluent, domestic sewage and municipal waste thrown into the lake.

REFERENCE

Comment [U24]: Please use more reference in the discussion part

- 1) **Jogesh, L. and Mithra, D. (2014)**Water quality status of Loktak lake, Manipur, Northeast India and need for conservation measures. A study of five selected villages. *International journal of scientific and research publication*,4(6):2250-3153.
- 2) **Prabhat, K.R. (2014)** A study of depleting water quality and wildlife resource of the Loktak lake, Manipur, India. *Issue and trends of wildlife conservation in Northeast India*,7(5):978-81
- 3) **Taruna, J., and Alankrita, C. (2013)** Assessment of water quality and its effects on the health of residents of Jhunjhunu district, Rajasthan: A cross sectional study. *Journal of Public Health and Epidemiology*. 5(4): 186-191
- 4) **Sarita, K., Jawad, A.K., Mahender, S.T. and Harinder, L., (2019).** Study of physico-chemical characteristics of water and soil relations to fish production in Motia lake reservoir. *Journal of atmospheric and earth science*, 2689-8780.
- 5) **Ritabrata, R. and Mrinmoy, M., (2019).** Assessment of water quality trends in LoktakLake , Manipur, India. *Environmental Earth Sciences* 13, 78:383
- 6) **Rajiv, D.K., Sarojini, D.B., Suganthi, K. and Munisamy, G. (2017)** Development of a water quality index (WQI) for the Loktak lake of India. *Appl water sci*, 7: 2909-2918
- 7) **J. George., S. K. Thakur., R. C. Tripathi., L.C. Ram., A. Ram., and S. Prasad, (2010).** Impact of coal industries on the quality of Damodar river water. *Toxicology and environmental chemistry*, 92:9, 1649-1664.
- 8) **Abbas, K. (2013)** Assessment of water quality in Tigris river- Iraq by using GIS mapping. *Article in natural resources*, 2013, 4, 441-448
- 9) **Ariyoli, A., Sathiamoorthi, T., Satheeshkumar, M., Joseph, S. J. and Boomi, P. (2016)** Study of water quality parameters of Cauveryriver water in Erode region. *Journal of global biosciences*, 5(9), 4556-4567