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Effect of Agricultural activities on Surface water quality of Kolthur and Sampambole Lakes of Medchal Malkajgiri district, Telangana India

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ABSTRACT

One essential natural resource for the existence of all ecosystems on Earth is water. Conventional irrigation techniques and the overuse of fertilizers for high product yields are the main source of contamination in a catchment's surface water. Chemical fertilizers such as Nitrogen, Phosphorus, Potassium (NPK), urea and manure are widely applied on agricultural farm lands to improve crop yield thereby compromising the quality of the water sources. Phosphorus is an important nutrient for plant growth. In aquatic systems, a lack of phosphorus often limits aquatic plant growth. Excess phosphorus is usually considered to be a pollutant. The present study focuses on the effects of agriculture on two Lakes i.e., Kolthur Lake and Sampambole Lake of Medchal-Malkajgiri district of Telangana by assessing the NPK and physico-chemical parameters. A total of eight and six samples were collected during the pre-monsoon, monsoon and post-monsoon season from Kolthur and Sampambole Lakes respectively. The study is done to assess the nitrates, phosphates and potassium levels in these Lakes to understand the effect on surface water upon fertilizer application. The parameters, pH, TA, TH, Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^- and F^-, all the samples in all the three seasons were found to be in the accepted limits of the BIS standard values. The other parameters which determine the water pollution due to agricultural activities are the turbidity, total dissolved solids, potassium, nitrates, phosphates, dissolved oxygen and biological oxygen demand were found to be exceeding the BIS standards, in majority of the samples. It was clearly observed that the intense agricultural practices have increased the nitrate and phosphate concentrations as well as other dissolved ions in both the Lakes.

Keywords: *Fertilizer, Agricultural Practices, Nitrate, Phosphate, Groundwater*

INTRODUCTION

One essential natural resource for the existence of all ecosystems on Earth is water. Less than 1% of the water resources on Earth, however, are available to people as fresh water, either as groundwater or surface water [1-2]. Water quality problems are often attributed to loadings of nutrients, chemicals, and pathogens into an aquatic system from point source and non-point source activities [3]. Out-dated agricultural management practices are the main source of contamination in a catchment's surface and ground water. These include conventional irrigation techniques, the overuse of fertilizers for high product yields, the application of pesticides and herbicides, and poorly managed animal agriculture enterprises [4]. Additional factors include untreated sewage pollution, rainfall-induced air deposits, fracking, and deforestation. However, the research presented in this paper focuses on the relationship between agricultural management practices and the decline in water quality. These activities may result in fluxes of nutrients, chemicals, pathogens, and sediment, as high losses of nitrogen and phosphorus are the main cause of nutrient problems [4].

Chemical fertilizers such as Nitrogen Phosphorus Potassium (NPK), urea and manure are widely applied on agricultural farm lands to improve crop yield thereby compromising the quality of the water sources [5]. Phosphorus is an important nutrient for plant growth. In aquatic systems, a lack of phosphorus often limits aquatic plant growth. Excess phosphorus is usually considered to be a pollutant.

The present study focuses on the effects of agriculture on two Lakes i.e., Kolthur Lake and Sampambole Lake of Medchal-Malkajgiri district of Telangana State.

Study Area

Kolthur Lake and Sampambole Lake both are found in the Medchal Malkajgiri district in Telangana, India. It falls under Shamirpet mandal. The water samples were collected from eight (K1 to K8) and six (S1 to S6) sample locations of Kolthur Lake and Sampambole Lake of Medchal Malkajgiri district during all the three seasons i.e., during the pre-monsoon (PRM), monsoon (MN) and post-monsoon (POM) and are shown in table 1a, 1b and fig 1. Both lakes are surrounded by the agricultural fields as shown in fig 2 and 3.

Table 1a: Sampling Locations of Kolthur Lake

S. No	Latitude	Longitude
K1	17.661879	78.639725
K2	17.663207	78.640258
K3	17.664124	78.640520
K4	17.664559	78.641196
K5	17.665728	78.640906
K6	17.665934	78.642351
K7	17.664125	78.641649
K8	17.662566	78.640742

Table 1b: Sampling Locations of Kolthur Lake

S. No	Latitude	Longitude
S1	17.63966	78.62605
S2	17.638986	78.62423
S3	17.638959	78.6219
S4	17.640998	78.62237
S5	17.641446	78.62488
S6	17.640434	78.62378

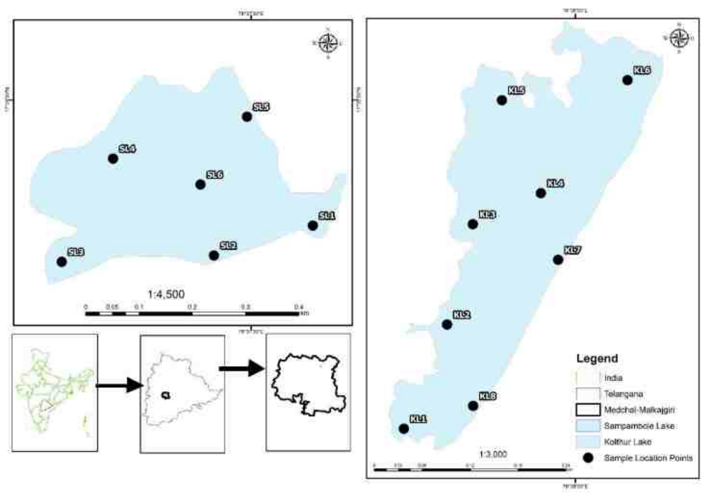

Fig 1: Map showing sample location points of both Kolthur and Sampambole Lake.

Fig 2: Google Earth Image showing the Kolthur Lake

Fig 3: Google Earth Image showing the Sampambole Lake

MATERIALS AND METHODOLOGY

The parameters assessed were pH, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), carbonates (CO_3^-), bicarbonates (HCO_3^-), sodium (Na), potassium (K), calcium (Ca^{+2}), magnesium (Mg^{+2}), chloride (Cl^-), fluoride (F^-), sulphates (SO_4^{-2}), phosphates (PO_4^{-3}), dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD). The determination of Dissolved Oxygen (DO) was done at the field using portable DO meter. Then they were taken to the laboratory and refrigerated at 4°C. The samples used for determination of Biological Oxygen Demand (BOD) were directly collected in BOD bottles by adding some drops of magnesium sulphate solution to fix dissolved oxygen. All other physico-chemical analysis was done using the APHA standard methods for the twenty parameters. The results were compared with the BIS (2012) standards.

RESULTS AND DISCUSSION

The results obtained for the both Lakes i.e., Kolthur Lake and Sampambole Lake during the PRM, MON and POM including the minimum, maximum and average values are shown in the table 2 and 3 respectively. The pH values ranged between 7.44 to 8.45 and 7.56 to 8.39 for Kolthur and Sampambole Lakes respectively. The EC values were between 811 to 1077 µS/cm for the Kolthur Lake and between 995 to 1133 µS/cm for the Sampambole Lake. The TDS were found to be in the range of 519 to 690 mg/L and 637 to 725 mg/L for Kolthur and Sampambole Lake respectively and found to be exceeding the acceptable limits of BIS standards in all the three seasons. The Turbidity was found to be in the range of 8 to 76 NTU and 8 to 94 NTU for Kolthur and Sampambole Lake respectively. It is also found that the turbidity was also exceeding the acceptable limits of BIS standards in all the three seasons. The Nitrates (NO_3^-) during the post monsoon season for all the samples except K1 and K2, K3 and K5 samples of the monsoon season were found to be exceeding the BIS acceptable standards. All the samples of pre-monsoon were within the acceptable limits for the Kolthur Lake. The values ranged between 25 to 73 mg/L. For the Sampambole Lake, all the samples of pre-monsoon were within the acceptable limits. Whereas for the S2, S3, S4 and S5 and all other samples of post-monsoon were found to be exceeding the acceptable limits of BIS acceptable limit. The values ranged between the 38 to 81mg/L. Blue baby syndrome, also known as methamoglobianemia, is a common illness in infants caused by high nitrate concentrations in drinking water. The fact that nitrate can be transformed into nitrosamines by bacteria in the digestive tract, which may cause cancer, is significant and adds to the concern about nitrate's effects on humans. Recent investigations have found that these compounds have strong carcinogenic effects. Water eutrophication, a condition where there are higher levels of nitrogen and phosphorous compounds in the water, leads to the growth of more aquatic plants and algae as well as the deterioration of the water environment and quality. This is one of the most significant adverse effects of intensive fertilizer use.

The Potassium (K^+) was exceeding the BIS limits during the post monsoon season of both Kolthur and Sampambole Lakes. The values ranged between the 3.1 to 17.6 mg/L for the Kolthur Lake and 3.1 to 26.2 mg/L for the Sampambole Lake respectively.

The Phosphates (PO_4^{2-}) were also found to be exceeding the BIS standard value for all the three seasons in both the Lakes and it was found to be between 1.1 to 8.9 mg/L for Kolthur Lake and 1.6 to 6.5 mg/L for the Sampambole Lake. Phosphorus is recognized as one of the major nutrients contributing to the increased eutrophication of Lakes and other natural waters [6].

The Dissolved oxygen was found to be within the acceptable limits for both the pre-monsoon and post-monsoon except for the monsoon. All the samples of monsoon were exceeding the acceptable limits and the values ranged between 1.5 to 6.5 mg/L for the Kolthur Lake. For the Sampambole Lake all the values were within the acceptable limits and the values ranged between 1.8 to 5.7 mg/L. The increase in value can be attributed to the addition of oxidisable organic matter from the effluents, biodegradation and decay of vegetation at higher temperature thereby taking oxygen from water [7-8]. For the Biological Oxygen demand parameter all the samples for all the seasons were exceeding the acceptable limits and the values ranged between 20 to 130 mg/L for the Kolthur Lake. For the Sampambole Lake all the values were exceeding the acceptable limits in all the seasons and the values ranged between 30 to 130 mg/L. The chemical oxygen demand values were between 70 to 360 mg/L for the Kolthur Lake and between 73 to 360 mg/L for the Sampambole Lake.

The parameters like turbidity, total dissolved solids, potassium, phosphates, dissolved oxygen and biological oxygen demand are found are exceeding the BIS standards in majority of the samples, which can be used to determine the water pollution due to agricultural activities

The carbonates values ranged between the 10 to 20 mg/L for both Kolthur and Sampambole Lakes respectively. The bicarbonates values were between 80 to 190 mg/L for the Kolthur Lake and between 106 to 194 mg/L for the Sampambole Lake. The total alkalinity values ranged between 90 to 190 mg/L and 110 to 194 mg/L for Kolthur and Sampambole Lakes respectively. The calcium values were between 38 to 59 mg/L for the Kolthur Lake and between 32 to 60 mg/L for the Sampambole Lake. The magnesium values ranged between 10 to 23 and 10 to 22 mg/L for Kolthur and Sampambole Lakes respectively. The TH values ranged from 144 to 199 mg/L in Kolthur Lake and 155 to 199 mg/L in Sampambole Lake. The Chloride values were between 160 to 230 mg/L for the Kolthur Lake and between 169 to 225 mg/L for the Sampambole Lake. The sodium values ranged between 84 to 164 mg/L and 122 to 171 mg/L for Kolthur and Sampambole Lakes respectively. The sulphates values were between 60 to 134 mg/L for the Kolthur Lake and between 85 to 151 mg/L for the Sampambole Lake. The fluorides values ranged between the 0.27 to 0.68 mg/L and 0.35 to 0.78 mg/L for Kolthur and Sampambole Lakes respectively. The pH, TA, TH, Na^+, Ca^{2+}, Mg^{2+}, Cl^- and F^-, all the samples in all the three seasons were found to be within the accepted limits of the BIS standard values.

Table 2: Chemical Analysis of water samples of Kolthur Lake for Pre-Monsoon, Monsoon and Post-Monsoon season (All parameters are in mg/L except pH, EC-µS/cm and Turbidity -NTU)

S. No	pH	EC	TDS	Turbidity	NO_3^-	PO_4^{3-}	K^+	DO	BOD	COD	TH	CO_3^{2-}	HCO_3^-	TA	Ca^{2+}	Mg^{2+}	Cl^-	Na^+	SO_4^{2-}	F^-
During Pre-Monsoon Season																				
BIS 2012	**6.5-8.5**	**1500**	**500**	**5**	**45**	**0.1**	**10**	**>5**	**<2**	**-**	**200**		**200**	**200**	**75**	**30**	**250**	**200**	**200**	**1**
1	8.4	970	621	60	28	1.5	6.1	2.8	57	170	144	10	80	90	38	12	215	159	108	0.6
2	8.4	965	617	72	30	1.6	5	3.2	76	210	160	10	110	120	41	14	210	140	105	0.5
3	8.4	1016	650	74	39	2.9	7	3.9	80	225	161	10	124	134	43	13	210	148	109	0.6
4	8.1	1018	652	54	25	2.3	5.3	3.4	105	294	177	Nil	136	136	48	14	205	152	120	0.6
5	8.1	1041	666	61	39	1.7	6.2	3.1	110	280	163	Nil	114	114	44	13	224	155	116	0.6
6	8.0	1023	655	76	29	2.9	7	2.7	118	330	190	Nil	130	130	45	19	230	147	99	0.7
7	7.8	1077	690	58	33	1.3	6	3.3	76	210	172	Nil	190	190	49	12	210	164	101	0.6
8	8.2	1024	656	70	30	1.4	6.9	3	95	280	182	Nil	112	112	50	14	220	148	119	0.5
Min	**7.8**	**965**	**617**	**54**	**25**	**1.3**	**5.0**	**2.7**	**57**	**170**	**144**	**Nil**	**80**	**90**	**38**	**12**	**205**	**140**	**99**	**0.5**
Max	**8.4**	**1077**	**690**	**76**	**39**	**2.9**	**7.0**	**3.9**	**118**	**330**	**190**	**10**	**190**	**190**	**50**	**19**	**230**	**164**	**120**	**0.7**
Avg.	**8.2**	**1017**	**651**	**66**	**32**	**2.0**	**6.2**	**3.2**	**90**	**250**	**169**	**3.8**	**125**	**128**	**45**	**14**	**216**	**152**	**110**	**0.6**
During Monsoon Season																				
1	7.7	811	519	10	26	3.3	3.8	4.3	32	112	188	Nil	110	110	44	19	185	100	75	0.5
2	7.5	937	599	8	47	3.8	3.2	4.1	47	140	195	Nil	131	131	50	17	194	122	87	0.7
3	7.6	981	628	12	46	3.3	4.6	4.8	40	130	194	Nil	130	130	40	23	205	136	95	0.5
4	7.9	989	633	9	45	3.3	3.4	4.2	40	120	183	Nil	158	158	52	13	180	143	101	0.6
5	7.9	988	633	11	57	4.5	4.3	3.7	53	170	164	20	153	173	41	15	180	140	91	0.5
6	7.4	984	630	13	42	8.9	4.4	2.1	130	360	178	Nil	150	150	50	13	200	140	90	0.6
7	7.6	1029	659	13	39	4.1	3.1	1.5	91	270	165	Nil	147	147	48	11	180	155	134	0.5
8	7.8	982	629	10	36	3.7	3.8	4.4	45	130	170	Nil	131	131	40	17	193	145	115	0.3
Min	**7.4**	**811**	**519**	**8**	**26**	**3.3**	**3.1**	**1.5**	**32**	**112**	**164**	**Nil**	**110**	**110**	**40**	**11**	**180**	**100**	**75**	**0.3**
Max	**7.9**	**1029**	**659**	**13**	**57**	**8.9**	**4.6**	**4.8**	**130**	**360**	**195**	**20**	**158**	**173**	**52**	**23**	**205**	**155**	**134**	**0.7**
Avg.	**7.7**	**963**	**616**	**11**	**42**	**4.4**	**3.8**	**3.6**	**60**	**179**	**180**	**3**	**139**	**141**	**46**	**16**	**190**	**135**	**99**	**0.5**
During Post-Monsoon Season																				
1	7.5	820	525	16	41	1.4	15	6.5	20	125	198	10	125	135	58	13	172	84	60	0.38
2	8.2	979	627	21	65	1.4	18	4.6	40	81	199	10	168	178	55	15	180	115	72	0.27
3	8.1	989	633	20	55	1.7	17	6.1	35	70	185	Nil	155	155	41	20	188	129	89	0.4
4	8.0	944	604	17	49	3.5	15	3.9	34	75	192	Nil	186	186	49	17	160	124	78	0.51
5	8.0	1001	640	25	73	2.1	16	5.9	45	156	182	Nil	189	189	50	14	179	130	65	0.29
6	7.6	957	612	31	59	3.05	17	2.6	80	314	187	Nil	182	182	42	20	178	127	60	0.57
7	7.9	906	580	24	50	2.7	17	5.3	45	214	189	Nil	160	160	59	10	173	107	68	0.35
8	7.7	937	600	19	46	1.1	15	2.9	39	70	186	Nil	153	153	53	13	187	122	71	0.4
Min	**7.5**	**820**	**525**	**16**	**41**	**1.1**	**15**	**2.6**	**20**	**70**	**182**	**10**	**125**	**135**	**41**	**10**	**160**	**84**	**60**	**0.3**
Max	**8.2**	**1001**	**640**	**31**	**73**	**3.5**	**18**	**6.5**	**80**	**314**	**199**	**10**	**189**	**189**	**59**	**20**	**188**	**130**	**89**	**0.6**
Avg.	**7.9**	**941**	**603**	**22**	**55**	**2.1**	**16.2**	**4.7**	**42**	**138**	**190**	**10**	**165**	**167**	**51**	**15**	**177**	**117**	**70**	**0.4**

Table 3: Chemical Analysis of Sampambole Lake water samples for Pre-Monsoon, Monsoon and Post-Monsoon season (All parameters are in mg/L except pH, EC-µS/cm and Turbidity NTU)

S. No	pH	EC	TDS	Turbidity	NO_3^-	PO_4^{3-}	K^+	DO	BOD	COD	TH	CO_3^{2-}	HCO_3^-	TA	Ca^{2+}	Mg^{2+}	Cl^-	Na^+	SO_4^{2-}	F^-
BIS 2012	**6.5-8.5**	**1500**	**500**	**5**	**45**	**0.1**	**10**	**>5**	**<2**	**-**	**200**	**-**	**200**	**200**	**75**	**30**	**250**	**200**	**200**	**1**
During Pre Monsoon Season																				
1	8.3	1079	690	68	39	1.7	8.9	3.1	80	168	170	Nil	121	121	32	22	216	171	128	0.8
2	8.4	1112	711	94	39	1.8	5.3	3.1	84	190	159	20	106	126	44	12	225	170	140	0.6
3	8.3	1052	673	58	45	2.7	6.4	2.4	130	360	186	Nil	110	110	40	21	195	148	151	0.6
4	8.3	1090	698	67	44	2.1	8.6	2.6	122	345	177	Nil	141	141	51	12	185	163	149	0.6
5	8.2	1096	702	73	42	3.4	7.5	3.1	97	310	185	10	151	161	56	11	206	160	122	0.6
6	8.4	1069	684	55	38	1.7	8.4	3.1	83	205	176	10	130	140	49	13	201	155	135	0.5
Min	**8.2**	**1052**	**673**	**55**	**38**	**1.7**	**5.3**	**2.4**	**80**	**168**	**159**	**10**	**106**	**110**	**32**	**11**	**185**	**148**	**122**	**0.5**
Max	**8.4**	**1112**	**711**	**94**	**45**	**3.4**	**8.9**	**3.1**	**130**	**360**	**186**	**20**	**151**	**161**	**56**	**22**	**225**	**171**	**151**	**0.8**
Avg.	**8.3**	**1083**	**693**	**69**	**41**	**2.2**	**7.5**	**2.9**	**99**	**263**	**176**	**13**	**127**	**133**	**45**	**15**	**205**	**161**	**138**	**0.6**
During Monsoon Season																				
1	7.8	1066	682	8	40	4.1	5.1	4.3	43	135	181	Nil	134	134	56	10	210	159	121	0.6
2	7.9	1045	669	14	46	3.4	3.7	4.4	41	120	163	Nil	138	138	39	16	217	161	103	0.5
3	7.9	995	637	11	51	4.9	3.1	2.8	65	170	187	Nil	170	170	52	14	174	136	104	0.4
4	7.8	1019	652	13	69	5.3	3.5	1.8	106	310	192	Nil	162	162	44	20	171	137	110	0.4
5	8.0	1049	671	15	57	6.5	3.9	2.9	80	250	179	10	180	190	42	18	185	151	100	0.5
6	7.8	1008	645	15	45	3.6	5.5	4.2	47	128	183	Nil	157	157	52	13	173	138	124	0.4
Min	**7.8**	**995**	**637**	**8**	**40**	**3.4**	**3.1**	**2**	**41**	**120**	**163**	**10**	**134**	**134**	**39**	**10**	**171**	**136**	**100**	**0.4**
Max	**8.0**	**1066**	**682**	**15**	**69**	**6.5**	**5.5**	**4**	**106**	**310**	**192**	**10**	**180**	**190**	**56**	**20**	**217**	**161**	**124**	**0.6**
Avg.	**7.9**	**1030**	**659**	**13**	**51**	**4.6**	**4.1**	**3**	**64**	**186**	**181**	**2**	**157**	**159**	**48**	**15**	**188**	**147**	**110**	**0.5**
During Post Monsoon Season																				
1	7.9	1133	725	20	47	1.9	18.9	4.2	40	73	199	Nil	189	189	60	12	207	152	114	0.6
2	7.7	1066	682	30	57	1.6	17.4	5.7	30	115	177	Nil	176	176	43	17	198	148	96	0.4
3	7.6	1022	654	18	59	3.8	24.5	2.9	62	129	181	Nil	175	175	46	16	169	129	105	0.4
4	7.7	1060	679	34	81	4.6	26.2	3.3	70	122	199	Nil	185	185	45	21	172	129	93	0.5
5	7.9	1031	660	26	69	4.2	17.7	2.6	81	267	191	Nil	194	194	50	16	170	135	85	0.5
6	8.0	1013	648	24	57	2	24.8	5.3	54	93	195	10	180	190	50	17	176	122	87	0.4
Min	**7.6**	**1013**	**648**	**18**	**47**	**1.6**	**17.4**	**3**	**30**	**73**	**177**	**10**	**175**	**175**	**43**	**12**	**169**	**122**	**85**	**0.4**
Max	**8.0**	**1133**	**725**	**34**	**81**	**4.6**	**26.2**	**6**	**81**	**267**	**199**	**10**	**194**	**194**	**60**	**21**	**207**	**152**	**114**	**0.6**
Avg.	**7.8**	**1054**	**675**	**25**	**62**	**3.0**	**21.6**	**4**	**56**	**133**	**190**	**2**	**183**	**185**	**49**	**17**	**182**	**136**	**97**	**0.5**

CONCLUSIONS

In the present study few samples showed that the values of Nitrates and Phosphates increased from pre-monsoon to post-monsoon. It indicates that through agricultural runoff of fertilizers into the Lakes is increasing their concentrations. Lake waters are being polluted by various physico-chemical parameters like turbidity, total dissolved solids, phosphates, dissolved oxygen, and biological oxygen demand which are reported to be over the acceptable levels of BIS 2012. Determining the amounts of phosphorus species in the environmental matrix is therefore required in order to supply crucial information for evaluating the condition of ecosystems, looking into biogeochemical processes, and keeping an eye on legal compliance.

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