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SURVEILLANCE ON THE SHORT AND LONG TERM VARIATIONS OF pH IN THE LOWER AND UPPER ZONES OF A TROPICAL ESTUARY

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ABSTRACT

Wetlands of India are estimated to be the repositories of aquatic biodiversity .Kerala is one of the green states of India and is well known for its wetlands. Kerala contain a few wetlands of International importance including Vembanad lake, Ashtamudi and Sasthamcotta lake that are designated as Ramsar sites Having recognized the importance of Ashtamudi as a wetland ecosystem that is subjected to acute pressure owing to rapid reclamation activities and indiscriminate utilization in the name of development. The present initiative was proposed for the evaluation of short and long term variations in the pH of the surface and bottom waters of the Ashtamudi wetland. The distribution of pH clearly indicated that the low pH values especially at the surface water during the monsoon months were due to heavy fresh water discharge and the increased pH values observed as the season progressed are due to higher sea water intrusion. Gradual decrease in pH values towards upstream which showed the influence of sea water on pH. The relatively higher pH values were recorded during the pre-monsoon and post-monsoon months. The study will help to identify the intensity of degradation that caused deterioration of water quality due to inadequate waste disposal, eco-tourist wastes, poultry waste, slaughter waste, land reclamation, sand mining, retting, inadequate port facilities, oil spills from thousands of fishing boats, industrial waste, human excreta, hospital waste, plastics etc. It throws light on the fact to create a conscientization to conserve the biodiversity values of the creek by promoting a monitoring of the degraded water quality of the creek.

KEYWORDS: Reclamation, Elico pH meter, deterioration, physico-chemical.

1. INTRODUCTION

Life on earth and around is supported by water through which the entire fabric of life is woven. Scientific indicators of estuarine ecosystems are related to its study of water quality. The dominant feature controlling the distribution, speciation and reactivity of chemical components within estuaries is the mixing of fresh and saline waters. These natural buffer zones between marine and fresh water regions are known to be highly productive compared to other ecosystems this inevitable resource of mankind by the introduction of untreated municipal waste and industrial effluents had led to water quality degradation, biodiversity loss and impacts of global climate change.

In the estuarine waters, pH values are mainly affected by river discharge, sea water intrusion and anthropogenic influences. The process of primary production, respiration and mineralization of organic matter are also able to alter the pH of the system because they can cause significant changes to the oxygen and carbon dioxide concentration of aquatic environments (Jose, 1993).[2] Variations in pH due to chemical and the industrial discharges render a stream unsuitable not only for recreational purposes but also for rearing of fish and other aquatic life (Webb, 1982).[8] The tolerance range for most aquatic organisms is quite narrow and critical. Close monitoring of pH values enable monitoring of pH values enable to identify zones of pollution and other quality conditions of water. pH is considered as important chemical parameter in water body since most of the aquatic organisms are adapted to an average pH and do not withstand abrupt changes. The pH of an estuary will tend to remain fairly constant because the chemical components of sea water resist large changes in pH (Philips, 2004).[6] Practically every analytical procedure associated with aquatic ecology and water pollution studies requires determination or adjustment of pH from one strip or the other.

The present study was planned with the objective of studying the seasonal variations of estuarine pH of the Ashtamudi estuary that flows through Kollam district of Kerala, one of the largest and deepest wetland ecosystem. Its fishery resources are composed of migrant stocks of both estuarine and marine species of

commercially important fishes. The physical and chemical dynamics of fishery resources are strongly influenced by the pH variations brought by the fresh water run-off and the adjacent open sea. Thus the study will help the biological monitoring for detecting the health of this aquatic ecosystem.

2. MATERIALS AND METHODS

Monthly water samples for hydrographical studies have been made from four selected sites of Thekkumbhagam creek of Ashtamudi estuary in Kollam district for a period of two years (From June 2008 to May 2010), covering three prominent seasons of the year (pre-monsoon, monsoon and post-monsoon). All collections were made invariably between 6 am and 8 am. The hydrogen ion concentration (pH) of water samples was measured using portable Elico pH meter. The data collected at monthly intervals from all the stations were statistically analysed, with a view to understand the nature of variations in the physico-chemical parameters between stations and seasons.

3. RESULTS

In Station 1, the pH of surface water ranged from 6.6 to 7.6 in 2008-2009 and from 7.1 to 7.95 in 2009-2010. The mean values during monsoon, postmonsoon, pre-monsoon were 7.65 ± 0.06, 7.3 ± 0.12, 7.22 ± 0.21 respectively in the first year and 7.37 ± 0.09, 7.38 ± 0.16, 7.39 ± 0.35 respectively in the second year. The annual mean $\pm$ SE was 7.29 ± 0.08 in 2008-2009 and 7.38 ± 0.12 in 2009-2010. (Table 1.1, and fig 1.1a &1.1b).

In Station 1, the pH of bottom water ranged from 6.1 to 7.8 in 2008- 2009 and from 7.05 to 7.8 in 2009-2010. The mean values during monsoon, postmonsoon, pre-monsoon were 7.22 ± 0.11, 7.47 ± 0.12, 6.7 ± 0.03 respectively in the first year and 7.41 ± 0.15, 7.55 ± 0.18, 7.38 ± 0.18 respectively in the second year. The annual mean $\pm$ SE was 7.13 ± 0.14 in 2008-2009 and 7.45 ± 0.09 in 2009-2010. (Table 1.1 and fig 1.2a &1.2b).

In Station 2, the pH of surface water ranged from 6.5 to 7.5 in 2008- 2009 and from 6.6 to 7.8 in 2009-2010. The mean values during monsoon, postmonsoon and pre-monsoon were 6.88 ± 0.2, 7.23 ± 0.23, and 7.2 ± 0.18 in the first year and 6.95 ± 0.2, 7.45 ± 0.16, 7.39 ± 0.35 in the second year. The annual mean $\pm$ SE was 7.12 ± 0.12 in 2008-2009 and 7.26 ± 0.14 in 2009-2010. . (Table 1.1, and fig 1.1a &1.1b).

In Station 2, the pH of bottom water was from 6.7 to 7.6 in 2008-2009 and from 6.7 to 7.9 in 2009-2010. The mean values during monsoon, post-monsoon and pre-monsoon were 6.82 ± 0.08, 7.25 ± 0.19, and 7.38 ± 0.13 respectively in the first year and 6.85 ± 0.06, 7.45 ± 0.24, 7.3 ± 0.07 in the second year. The annual mean $\pm$ SE was 7.15 ± 0.14 in 2008-2009 and 7.20 ± 0.11 in 2009-2010. (Table 1.1 and fig 1.2a &1.2b).

In Station 3, the pH of surface water varied from 6.6 to 7.9 in 2008- 2009 and from 6.6 to 7.4 in 2009-2010. The mean values during monsoon, postmonsoon and pre-monsoon were 7.37 ± 0.23, 7.1 ± 0.24, and 7.23 ± 0.09 respectively in the first year and 7.1 ± 0.19, 7.03 ± 0.19, 7.2 ± 0.09 respectively in the second year. The annual mean $\pm$ SE was 7.23 ± 0.11 in 2008-2009 and 7.11 ± 0.09 in 2009-2010. (Table 1.1, and fig 1.1a &1.1b).

In Station 3, the pH of bottom water ranged from 6.8 to 7.6 in 2008- 2009 and from 6.8 to 7.7 in 2009-2010. The mean values during monsoon, postmonsoon and pre-monsoon were 7.12 ± 0.12, 7.23 ± 0.18, and 7.38 ± 0.17 respectively in the first year and 7.19 ± 0.11, 7.35 ± 0.18, 7.35 ± 0.16 respectively in the second year. The annual mean $\pm$ SE was 7.24 ± 0.09 in 2008-2009 and 7.29 ± 0.08 in 2009- 2010. (Table 1.1 and fig 1.2a &1.2b).

In Station 4, the pH of surface water was from 6.5to 7.8 in 2008-2009 and from 6.6 to 7.8 in 2009-2010. The mean values during monsoon, post-monsoon and pre-monsoon were 7.2 ± 0.3, 7.25 ± 0.13, and 7.6 ± 0.04 respectively in the first year and 7.07 ± 0.21, 7.03 ± 0.18, 7.65 ± 0.05 respectively in the second year. The annual mean $\pm$ SE was 7.35 ± 0.12 in 2008-2009 and 7.34 ± 0.11 in 2009-2010. (Table 1.1, and fig 1.1a &1.1b).

In Station 4, the pH of bottom water ranged from 6.8 to 8.1 in 2008- 2009 and from 6.8 to 8.3 in 2009-2010. The mean values during monsoon, postmonsoon and pre-monsoon were 6.85 ± 0.03, 7.33 ± 0.29, and 7.83 ± 0.21 respectively in the first year and 6.89 ± 0.01, 7.4 ± 0.28, 7.8 ± 0.25 respectively in the second year.The annual mean $\pm$ SE was 7.33 ± 0.16 in 2008-2009 and 7.36 ± 0.16 in 2009-2010. (Table 1.1 and fig 1.2a &1.2b).

ANOVA comparing pH of surface water showed variations for periods within seasons for the 2008-2009 significant at it1 level. ANOVA comparing pH of surface water between the years of study revealed that the station1 showed variations significant at 1% level for periods within seasons. Station 2 and Station 3 showed variations between years significant at 1% level. Station 4 showed variations significant between seasons, years and for periods within seasons at 1% level (Table 1.2,1.3).

ANOVA comparing pH of bottom water showed no significant variations. In the case of stations 2,3 and 4, pH between the years of study showed variations between years significant at 1% level (Table 1.4 & 1.5).

Table 1.1: p^H of water (2008-2010).

Year	Season	Month	p^H							
			Station 1		Station 2		Station 3		Station 4	
			Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
2008-2009	Monsoon	JUN	7.3	7	7.14	7.02	7.9	7.18	7.8	6.8
		JUL	7.23	7.5	7.29	6.86	6.96	6.8	6.9	6.9
		AUG	7.5	7.3	6.5	6.7	7	7.1	6.5	6.8
		SEP	7.4	7.08	6.6	6.7	7.6	7.4	7.6	6.9
	Post-Monsoon	OCT	7.1	7.3	7.5	7.7	6.8	7.1	7.5	8.1
		NOV	7.4	7.5	7.4	7.4	7.6	7.4	7.1	7
		DEC	7.6	7.8	7.6	7.1	7.4	7.6	7.6	7.4
		JAN	7.1	7.3	6.6	6.8	6.6	6.8	6.8	6.8
	Pre-Monsoon	FEB	7.5	7.4	6.7	7	7.1	6.9	7.6	7.3
		MAR	6.6	7	7.2	7.4	7.5	7.6	7.7	7.7
		APR	7.5	6.1	7.4	7.6	7.1	7.4	7.5	8.2
		MAY	7.3	6.3	7.5	7.5	7.2	7.6	7.6	8.1
2009-2010	Monsoon	JUN	7.24	7.05	7.19	6.94	7.04	7.3	7.11	6.84
		JUL	7.23	7.4	7.39	6.96	6.67	6.87	6.98	6.9
		AUG	7.6	7.4	6.6	6.8	7.1	7.2	6.6	6.9
		SEP	7.4	7.8	6.6	6.7	7.6	7.4	7.6	6.9
	Post-Monsoon	OCT	7.1	7.2	7.6	7.8	6.7	7.2	7.7	8.2
		NOV	7.6	7.8	7.8	7.9	7.4	7.6	7.1	7.2
		DEC	7.7	7.9	7.7	7.2	7.3	7.7	7.5	7.3
		JAN	7.1	7.3	6.7	6.9	6.7	6.9	6.9	6.9
	Pre-Monsoon	FEB	7.4	7.3	6.8	7.1	7	6.9	7.6	7.1
		MAR	6.4	7.1	7.3	7.4	7.4	7.6	7.8	7.8
		APR	7.95	7.21	7.8	7.4	7.1	7.4	7.6	8.3
		MAY	7.8	7.9	7.6	7.3	7.3	7.5	7.6	8

Table 1.2: ANOVA testing surface water pH between the stations and seasons.

Source	2008-2009				2009-2010			
	DF	Sum of squares	Mean Sum of squares	F Ratio	DF	Sum of squares	Mean Sum of squares	F Ratio
Total	47	6.40			47	7.40		
Between stations	3	0.40	0.10	1.10	3	0.50	0.20	1.30
Between seasons	2	0.10	0.10	0.48	2	0.60	0.30	2.45
Periods within seasons	9	2.37	0.26	2.4*	9	1.99	0.22	1.87
Error	33	3.62	0.11		33	4.30	0.13	

Table 1.3: ANOVA testing surface water pH between the years of study in stations.

Source	Station 1				Station 2			
	DF	Sum of squares	Mean Sum of squares	F Ratio	DF	Sum of squares	Mean Sum of squares	F Ratio
Total	23	2.70			23	1107.30		
Between years	1	0.00	0.00	1.90	1	768.90	768.90	40.6**
Between seasons	2	0.00	0.00	0.29	2	14.50	7.30	0.38
Periods within seasons	9	2.41	0.27	12.16**	9	115.66	12.85	0.68
Error	11	0.24	0.02		11	208.22	18.93	

Source		Station 3				Station 4		
	DF	Sum of squares	Mean Sum of squares	F Ratio	DF	Sum of squares	Mean Sum of squares	F Ratio
Total	23	853.40			23	1537.50		
Between years	1	555.90	555.90	38.9*	1	1025.50	1025.50	45.3**
Between seasons	2	65.90	33.00	2.31	2	79.00	39.50	1.75
Periods within seasons	9	74.43	8.27	0.58	9	184.03	20.45	0.90
Error	11	157.06	14.28		11	248.97	22.63	
	* denote significance ($p < .05$)							
	** denote significance($p<.01$)							

Table 1.4 ANOVA testing bottom water pH between the stations and seasons.

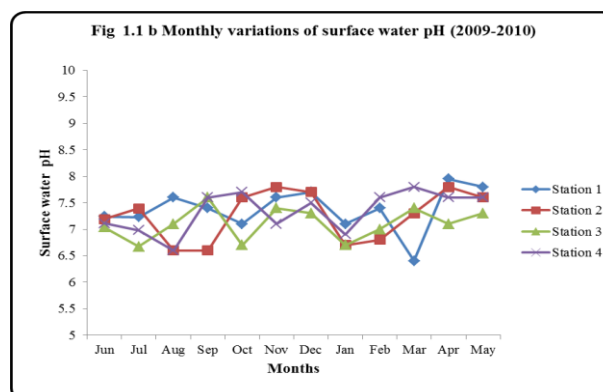| Source	2008-2009			2009-1010		
	Sum of squares	Mean Sum of squares	F Ratio	Sum of squares	Mean Sum of squares	F Ratio
Total	8.80			7.40		
Between stations	0.30	0.10	0.50	0.40	0.10	1.20
Between seasons	1.10	0.50	2.79	1.40	0.70	6.21**
Periods within seasons	1.11	0.12	0.64	1.88	0.21	1.85
Error	6.32	0.19		3.73	0.11	

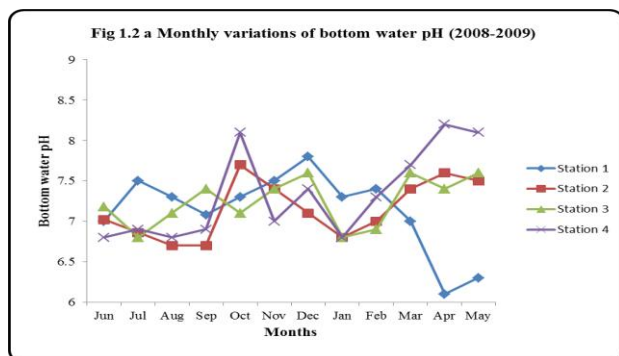**Table 1.5: ANOVA testing bottom water pH between the years of study in stations.**

Source	Station 1			Station 2		
	Sum of squares	Mean Sum of squares	F	Sum of squares	Mean Sum of squares	F
Total	4.40			283.50		
Between years	0.60	0.60	4.00	127.90	127.90	13**
Between seasons	0.90	0.50	3.05	8.00	4.00	0.40
Periods within seasons	1.23	0.14	0.92	39.33	4.37	0.44
Error	1.64	0.15		108.34	9.85	

Source	Station 3			Station 4		
	Sum of squares	Mean Sum of squares	F	Sum of squares	Mean Sum of squares	F
Total	193.10			827.20		
Between years	87.40	87.40	23.3**	589.60	589.60	55.7**
Between seasons	22.20	11.10	2.96	3.30	1.70	0.16
Periods within seasons	42.27	4.70	1.25	117.76	13.08	1.24
Error	41.24	3.75		116.50	10.59	

* denote significance ($p < .05$)

** denote significance ($p < 01$)

Fig 1.1a Monthly variations of surface water pH (2008-2009)

Fig 1.1 b Monthly variations of surface water pH (2009-2010)

Fig 1.2 a Monthly variations of bottom water pH (2008-2009)

Fig 1.2 b Monthly variations of bottom water pH (2009-2010)
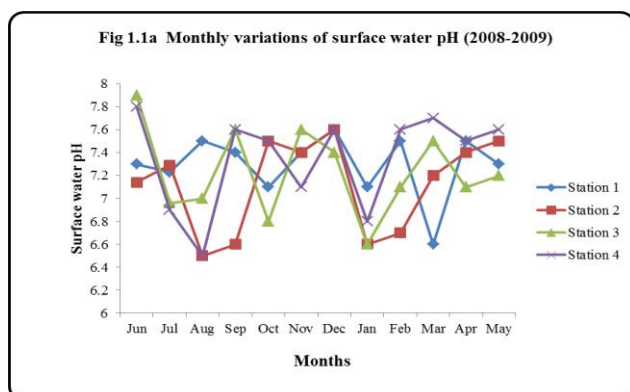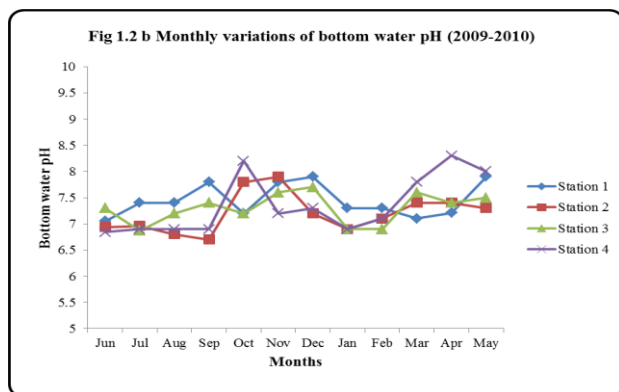
4. DISCUSSION

pH measurements provide a very quick and easy way to obtain the appraisal of the acid base equilibrium in an ecological system. The pH of a medium depends on factors like photosynthetic activity, discharge of industrial effluent, nature of dissolved materials, rainfall etc. pH of surface water ranged from 6.5 to 7.6 in the first year and 6.4 to 7.9 in the second year. pH of bottom water ranges from 6.1 to 8.2 in 2008-2009 and 6.7 to 8.3 in 2009-2010. Very low pH values and high pH values were recorded in certain months irrespective of seasons. Variations in pH values may be acidic or alkaline due to industrial discharges. The industrial effluents discharged in to the aquatic system may significantly lower or elevate the pH of water depending on the nature of effluents (Babu *et al.,* 2000)[1] Rivers transporting large quantities of humic material in colloidal suspension are frequently slightly acidic. Upon meeting the sea water, the colloidal particles were coagulated and the pH shifts towards the alkaline side (Reid, 1961).[7]

The distribution of pH clearly indicated that the low pH values especially at the surface water during the monsoon months were due to heavy fresh water discharge and the increased pH values observed as the season progressed are due to higher sea water intrusion. Gradual decrease in pH values towards upstream which showed the influence of sea water on pH. The relatively higher pH values recorded during the pre-monsoon and post-monsoon months may be due to the removal of carbon dioxide by photosynthetic activity which is higher during these periods. Generally lower pH values at the upstream than at downstream, might have resulted from

decaying of the domestic and industrial wastes. Carbon dioxide produced by decomposition and respiration can decrease pH of marine waters to 7.5 and photosynthesis can increase it to 9 (Levinton, 1982).[3] This may also be one reason for the variation of pH. The pH gets changed due to the changes in the temperature, salinity and biological activity. pH remains alkaline registering a maximum during summer season, which could be attributed to the high salinity of water. pH was low during the monsoon season and this was associated with lesser salinity and biological activity.pH becomes acidic in certain months, that can result in death as well as a variety of subtle effects. Values less than 6 results in a marked decrease in some oogensis egg fertility or growth of fry, or egg hatchability and growth (Mathews, 1998).[4] Nair *et al.,* (1983).[5] observed a clear decrease in pH from marine to fresh water zone in the Ashtamudi estuary. Biological activities however significantly alter pH levels in an estuary. The BIS (ISI) standard for pH of inland surface water for use as raw water, public water supply and for bathing is 7.9.(ISI, 1983).The Indian Council of Medical Research (ICMR) standard for the same is 7 to 8.5. The pH values in the study area remained within permissible limits only for certain periods.

5. CONCLUSION

Declining water quality is an acute problem around the world, particularly in developing countries where there are notable increase in agricultural and industrial production coupled with a lack of adequate waste water treatment. Main sources of pollution include oil spillage from fishing boats of Neendakara, industrial wastes, coconut husk retting, untreated sewage, and human excreta etc. In addition the habitat of various marine organisms faces serious degradation due to activities such as reclamation of the estuary. The seepage of polluted water from the estuary in to the wells in the estuarine shores is a major health hazard for many who live around estuary and depend on wells for drinking safe water. Monitoring the fluctuations in water pH is needed to understand the dynamics of this aquatic ecosystem. The scientific knowledge provide by this work will remind the need for its restoration.

6. ACKNOWLEDGEMENT

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