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RESEARCH ARTICLE

DYNAMIC CHANGES IN THE CHLORIDE AND FLUORIDE LEVELS OF THAMIRAPARANI (WEST) RIVER

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ABSTRACT

The Chloride and Fluoride are two key factors in any aquatic ecosystems. The present paper highlights the seasonal variations of Chloride and Fluoride in Tamiraparani River (West) from June 2011 to May 2013. Twelve stations were selected for the study. The study reveals that high Chloride of 1050 mg/l was found in S12, during the months of June to August 2012, low chloride of 10 mg/l was found in stations S4, S5 during December to February 2011-2012, March to May 2012. The Fluoride was found high in stations S4, S6 as 0.6mg/l during June to August September to November 2011and June to August, September to November 2012, March to May 2013 and low Fluoride of 0.1mg/l was found in stations S1, S2, S4-S12 during December to February 2011-2012 and March to May 2012. The Fluoride levels seem to be high in upper reaches and a decreasing trend is found towards estuary. In contrary, Chloride level was low in upper reaches and it increases at the upper reaches of estuary and was maximum in the last station (S12). However, higher Chloride level was found during South West monsoon seasons in all the station studied. The fluctuation in due to rain water influx is also discussed. The Chloride and Fluoride was found to be significantly correlated (r=0.8021) in the 7th degree polynomial fit and the relationship established and discussed.

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INTRODUCTION

Life originated in water and life is nurtured with water, earth and ecosystem are sustaining with the availability of water. On this long standing life promoting nature of water, water quality assessment with physical, chemical and biological characteristics becomes essential. The water quality standards vary significantly due to different environmental conditions, ecosystems, and intended human use (Diersing and Nancy, 2009). In early days water was used only for domestic needs like drinking, washing, bathing and cooking. But now industrial and urban development prove to be a challenge and so quality water is required for living organisms. The water systems in India with industrial and urban centers receive a large amount of effluents either partially treated or untreated, thus affecting the quality of water. Sampoorani *et al* (2002) reported pollution from domestic waters and pulp mill effluent in the Cauvery river. In the southern part of India among the South Indian rivers "Thamiraparani" river is located in the southern most part of Peninsular India and serves as the chief source of water for drinking and agricultural purposes of Kanyakumari District. Industrial pollutions over the water quality of the river has made concern to be strongly felt. Within the district of Kanyakumari, the West Thamiraparani river originates from the Mahenthragiri hills of the Western ghats with an elevation of 1,645.2 metres and passes by the Kodayar dam (Semila *et al* 2014). It shares through a 60 km length and confluences with the Arabian Sea at the Thengapatanam estuary (7º53' N and 70º07'E). Due to urban development, large scale sand mining, mushrooming brick kilns, coir retting as well as automobile, domestic and industrial waste the river water is now gradually undergoing eco-degradation. The rubber sediments also dissolves within the river and thus water segments by the rubber estates is a threat to the domestic use of water to human being. However, this study is hardly available on the seasonal dynamics of Chloride and fluoride of the Thamiraparani (West) river along the altitudinal gradient of 0 to 1000 ft. With this interest in view, the present investigation was planned and carried out.

Location of Study: The Thamiraparani (west) river which irrigates a major part of Kanyakumari district was selected for the present study. Water samples were collected from 12 different sites (Table. 1). Water sample was collected in polythene bottles of 2 litres and carried to the laboratory, where

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physio-chemical parameters were analyzed as per standard methods (APHA, 2011). The parameters selected for analysis were Chloride and Fluoride for the two years June 2011 to May 2013 in four seasons each.

Statistical Analysis: Analysis of variance (ANOVA) comparing the difference among different stations was carried out using MINITAB software and the nonlinear relationship between Fluoride and Chloride was carried out using CURVEXPERT software and the best mathematical model was determined using R^2 and SE values.

Table 1. Study location during the present investigation

S.No	Station No.	Locality	Latitude	Longitude	Altitude (ft above msl)
1.	S.1	Lower Kodayar	8°31'11.75"N	77°18'36.75"E	930
2.	S.2	Kuttiyar	8°30'03.27"N	77°18'11.59"E	347
3.	S.3	Mothiramalai	8°29'55.28"N	77°17'56.56"E	433
4.	S.4	Kadaiyalumoodu	8°24'42.77"N	77°16'51.55" E	211
5.	S.5	Kaliyal	8°23'57.03"N	77°15'31.47" E	194
6.	S.6	Tiruparapu	8°23'28.49"N	77°15'31.46"E	161
7.	S.7	Muvattumugom	8°20'35.73" N	77°15'04.98" E	68
8.	S.8	Gnaranvilai	8°19'10.75" N	77°13'26.47" E	63
9.	S.9	Kuzhithurai	8°18'33.42" N	77°12'31.11" E	58
10.	S.10	Ganapathiyankadavu	8°17'13.57"N	77°10'16.58" E	57
11.	S.11	Pallikal	8°16'17.63" N	77 °09'46.61" E	57
12.	S.12	Thengapattanam	8°14'24.65" N	77°10 '11.92" E	5

Table. 2 Seasons during the period of investigation

Years	Months	Season
2011	June - August	South West Monsoon
2011	September – November	North East Monsoon
2011-12	December – February	Winter
2012	March - May	Summer
2012	June - August	South West Monsoon
2012	September – November	North East Monsoon
2012-13	December – February	Winter
2013	March – May	Summer

Table 3. One-Way Analysis of Variance comparing the Chloride levels in the different stations of Thamiraparani (west) river.

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	11	4611997	419272	92.15	0.000
Error	84	382172	4550		
Total	95	4994169			

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	--+---------+---------+---------+----
S1	8	18.63	5.60	(-*-)
S2	8	21.25	5.09	(-*-)
S3	8	21.00	7.07	(-*-)
S4	8	31.87	13.51	(-*-)
S5	8	28.62	11.55	(-*-)
S6	8	16.75	5.92	(-*-)
S7	8	20.25	5.50	(-*-)
S8	8	20.75	4.40	(-*-)
S9	8	22.50	4.63	(-*-)
S10	8	42.62	15.30	(-*-)
S11	8	62.25	6.34	(*-)
S12	8	819.62	231.93	(-*-)
				--+---------+---------+---------+----

Pooled StDev = 67.45

RESULTS AND DISCUSSION

Analysis of variance reveals that in Table -3 the Chloride level differs significantly in different stations of the study area (P< 0.01). The high chloride levels are seen in S10, S11& S12. This is due to the salinity found in estuarine region due to influx of sea water at Thengapattinam, which extends as a gradient up to station 9 & 10. The study also reveals (Figure 1) that high Chloride of 1050 mg/l was found in S12, during the months of June to August 2012, low chloride of 10 mg/l was found in stations S4, S5 during December to February 2011-2012, March to May 2012. In all natural waters as reported by Yadav and Rajesh (2011), the occurrence of Chloride seems widely varying concentrations. In the present study, Chloride level was low in upper reaches and it increases at the upper reaches of estuaries, low and high in the last station. However, higher Chloride level was found during South West monsoon seasons in all the station studied. The fluctuation may be due to rain water influx. The fluctuation in the concentration of Chloride is a usual process due to the dilution and rapid flow of the water.

Table 4. One-Way Analysis of Variance comparing the Fluoride levels in the different stations of Thamiraparani (west) river.

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	11	4611997	419272	92.15	0.000
Error	84	382172	4550		
Total	95	4994169			

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	--+---------+---------+---------+----
S1	8	18.63	5.60	(-*-)
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S6	8	16.75	5.92	(-*-)
S7	8	20.25	5.50	(-*-)
S8	8	20.75	4.40	(-*-)
S9	8	22.50	4.63	(-*-)
S10	8	42.62	15.30	(-*-)
S11	8	62.25	6.34	(*-)
S12	8	819.62	231.93	(-*-)
				--+---------+---------+---------+----

Pooled StDev = 67.45

However, the increase in Chloride in the present study may be due to influx of sea water which has high levels of Chloride. Analysis of variance (Table 4), reveals that the chloride level of different stations of the river differs significantly (p<0.01). The Fluoride was found high in stations S4, S6 as 0.6mg/l during June to August, September to November 2011 and June to August, September to November 2012, March to May 2013 and low Fluoride of 0.1mg/l was found in stations S1, S2, S4-S12 during December to February 2011-2012 and March to May 2012. The Fluoride levels seem to be high in upper reaches and a decreasing trend is found towards estuary. This phenomenon occurs in contact with natural deposits of fluoride such as fluorspar, calcium fluoride, cryolite and water contaminated with industrial effluents (Gogana, 2014). Vinod *et al.* (1997) points out that high fluoride concentration in ground water resources is a major toxicological and geo-environmental issue of India. Ultimately the recommended value of W.H.O for artificial fluoridation is 0.5-1.0 (Krishnakumar et.al 2013). However, the fluoride level in the present study is within safe limits.

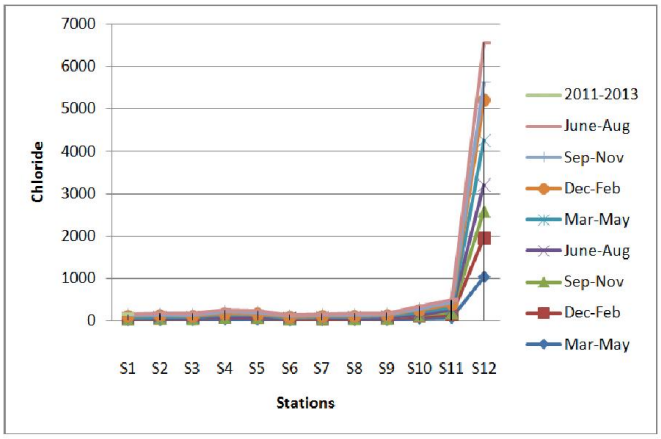

Fig. 1. Seasonal Variation in Chloride of river Thamiraparani (West) during the study period

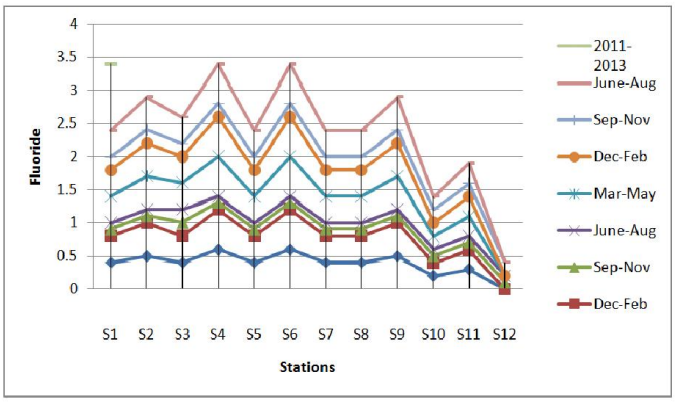

Fig. 2. Seasonal Variation in Fluoride of river Thamaraparani (West) during the study period

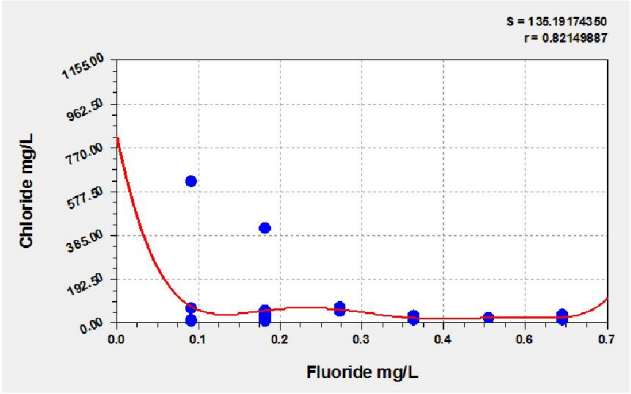

Fig. 3. Seventh degree Polynomial fit correlating Chloride with Fluoride

The Chloride and Fluoride was found to be significantly correlated (r=0.8021) in the 7th degree polynomial fit and the relationship established (Fig. 3) and the relationships can be expressed as

$$\text{Chloride} = 8.1516 - 1.5806\text{F} + 1.1625\text{F}^2 - 3.6214\text{F}^3 + 3.3895\text{F}^4 + 6.0508\text{F}^5 - 1.5217\text{F}^6 + 8.9624\text{F}^7$$

Where F = Fluoride

This inverse relationship of Chloride and Fluoride is explicitly identfied in this study (Fig. 3). Because the study involves the full stretch of the Thamiraparani river, a negative relationship is obviously assessed in the relationship of Chloride and Fluoride. Whereas, the dissertation work of Sheeja (2005) determines a positive relationship of such parameters, however the negative implication suggests the inverse relationship. Reports made by Pazhanisamy and Ebanasar (2008) resounds that polynomial fit as the best fit model in expressing the relationship between physical characteristics of water in reservoir. On this investigation, the result of the present study is also in agreement with the observation of Pazhanisamy and Ebanasar (2008). Hence, the results also reveal that the river has peculiar type water quality characteristic during the flow and also maintain remarkable relationship with the altitude of the sampling sites.

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