

ENVIRONMENTAL IMPACT ASSESSMENT OF CAUVERY RIVER WITH DIATOMS AT BHAVANI TAMIL NADU INDIA

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ABSTRACT

The environmental studies of diatoms and river water chemistry in Cauvery River at Bhavani, Tamil Nadu for the period of January 2012 have been studied. 37 diatom species were identified and water quality assessment. From the data it was found that the polluted water in the study area has presents the dominance of diatom species *Achnanthes minutissima*, *Cyclotella meneghiniana*, *Cymbella tumida*, *Cymbella aspera*, *Gomphonema lanceolatum*, *Pleurosigmasalinarum* and *Synedra ulna*. This is also evident by Principal component analysis and Detrended correspondence analysis. This study asses the reason for variation in community composition with location specific environmental characteristics.

Key words: Environmental Studies, Diatom, Water Quality Assessment and Cauvery River

INTRODUCTION

Diatoms are susceptible to environmental conditions in river and their distribution is mainly governed by the physicochemical composition of the water. Diatoms are single celled microscopic algae that possess tremendously ornamented cell wall composed of glass silica (SiO_2) which provide diversity of shapes from nano to microscope structures. They are free floating planktonic or attached to a substrate, benthic forms (Werner, 1997). Most every one of species is good indicators for a range of water quality variables because they have narrow optima and tolerances for many environmental variables (Van Dam *et al.*, 1994). River diatoms are sensitive to pollution or other events and are therefore commonly used for

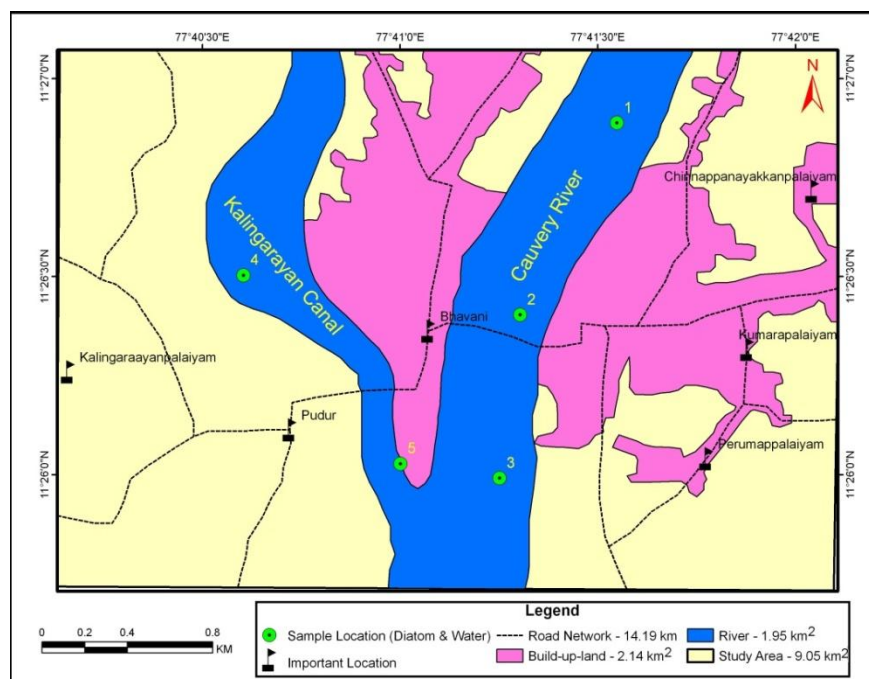


Figure 1: Map of the Study area with sample locations

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monitoring environmental pollution. To monitor changes in the environment, many methods have been used (Whitton et al., 1991). Diatoms can provide valuable information for monitoring rivers, particularly on organic pollution (Sladeczek, 1986). Diatoms have been used to monitor river pollution (Wu & Suen, 1985; Wu, 1986). The investigations in river diatoms are scanty due to practical difficulties in the survey and sampling of flowing water. However, diatoms of fresh water rivers have been studied extensively in India (Mishra and saksena, 1993, Somasekar, 1988, Trivedy and Khatavkar, 1996). Various diatom groups prefer to exist in various kinds of water. The development of a diatom community in a river depends directly upon the physical factors of flow and turbidity and when either or both of these are too great, no appreciable populations can be formed. This study to determine if there is any significant difference in the abundance and diversity of the diatom population at different stations.

Study Area

The study area lies at 77°40' E to 77°42' E longitude and 11°25'N to 11°27' N latitude with an area of 9.05 sq. km (Figure1). The Cauvery River is one of the major rivers of South India. The Cauvery rises at Talakaveri on the Brahmagiri Range of Hill in Western Ghats of India. The river has an approximate length of 760 km flows in the South and East through Karnataka and Tamil Nadu States. The Kalingarayan Canal is a 90 km long irrigation canal in the Erode region of Tamil Nadu, India. It was constructed by Kongu chieftain Kalingarayan and completed in the year 1823. This runs parallel to Cauvery River. The canal was designed with a meandering route to maximize the amount of agricultural land which benefited.

MATERIALS AND METHODS

Diatom and water samples were collected in polythene bottles from all obtainable habitats such as plants (epiphytic) and stones (epilithic) following Taylor et al., (2007a) and Karthick et al., (2010). Further, diatom samples were collected by brushing stones with a toothbrush, following recommendations of Kelly et al. (1998). At least five, pebbles to cobble (5-15 cm) sized stones were collected from the river bottom. They were brushed and the diatom suspension was put in a small plastic bottle. Epilithic and epipellic diatoms were sampled at five sampling stations during January on 2012. Epiphytic samples were taken by brushing the undersurfaces and petioles of at least five plant leaves and roots. In all studies, diatom samples were preserved in formaldehyde (4%).

Table 1: Anions & Cations Concentration in river water Samples (All values in the table are expressed in ppm except EC in μScm^{-1} and pH / TDS in ppm)

Location	P H	T	EC	TDS	D O	BO D	CO D	N	P	TH	Ca H	Mg H	CH L	AL K
Angalamman Temple	7.5 2	27. 80	1203. 23	560. 67	5.6 7	13. 8	80. 01	0.0 13	0.0 24	236. 67	91. 23	57. 83	272. 12	151. 00
Kumarapalaiyam	7.6 7	26. 57	1015. 67	937. 00	5.8 1	12. 89	42. 32	0.0 14	0.0 30	243. 97	89. 00	56. 19	285. 34	151. 11
Kumarapalaiyam south	7.8 1	26. 60	1223. 33	769. 33	6.8 9	7.9 0	65. 08	0.0 12	0.0 14	322. 93	82. 23	57. 58	277. 81	159. 01
Kalingarayan canal	7.1 2	24. 33	843.3 3	535. 00	3.8 7	3.2 0	10. 91	0.0 14	0.0 05	119. 33	79. 67	33. 35	65.9 6	115. 33
Kuduthurai	7.1 5	24. 00	404.0 0	270. 00	3.6 0	2.9 2	10. 65	0.1 23	0.0 02	131. 00	76. 93	18. 51	42.4 0	110. 00

For Polarizing microscopy analysis, a 10 ml epiphytic and epilithic subsamples were extracted and cleaned using 30% H_2O_2 and concentrated HNO_3 (Stoermer et al., 1995). Identification of diatoms was carried out using taxonomic guides (Gandhi, 1957 1959a, 1959b, 1961, 1962, 1967; Karthick et al., 2008).

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Taxonomic identification was performed according to mainly Krammer & Lange-Bertalot (1986, 1988, 1991a, b) and guidelines given in Barber & Haworth (1981). 5 river water samples from various locations of the study area were collected during pre-monsoon season (January 2012). The locations of water sampling stations are shown in the Table 1. Samples were stored in polythene bottles and were standard to laboratory for further analysis. Parameters like pH, electrical conductance and water temperature (°C) were measured within a few hours of collection by using Elico pH meter and conductivity meter respectively. Calcium and Magnesium were determined titrimetrically using standard EDTA, and chloride was determined by silver nitrate titration (Volgel, 1968). Sodium, Potassium, Phosphates, Biological oxygen demand (BOD), Chemical oxygen demand (COD) and Dissolved oxygen (DO) were analyzed in laboratory and analyses were assessed by using standard method for the assessment of water quality as mentioned in Trivedy and Goel (1986).

Statistical analyses comprising Principal component analysis (PCA) was performed using PAST 2.04 version software to explain the water quality variation. Detrended correspondence analysis (DCA), a multivariate statistical technique for analyzing environmental data of a community (using PAST 2.04 versions) was used to study the major patterns of community composition and maximum amount of variation in the diatom distribution across the rivers.

RESULTS AND DISCUSSION

The present recorded a total of 37 diatom belonging to 17 genera species *Achnanthes inflata*, *Achnanthes minutissima*, *Amphora ovalis*, *Caloneis pulchra*, *Cocconeis placentula*, *Caloneis silicula*, *Cyclotella catenata*, *Cyclotella meneghiniana*, *Cymbella aspera*, *Cymbella cymbiformis*, *Cymbella tumida*, *Cymbella tumidula*, *Cymbella turgida*, *Cymbella ventricosa*, *Eunotia fallax*, *Fragilaria intermedia*, *Gomphonema gracile*, *Gomphonema lanceolatum*, *Gomphonema olivaceum*, *Gomphonema undulatum*, *Navicula mutica*, *Nitzschia palea*, *Nitzschia pseudofonticola*, *Nitzschia recta*, *Nitzschia sigma*, *Nitzschia thermalis*, *Melosira granulata*, *Pinnularia acrosphaeria*, *Pleurosira indica*, *Pleurosira salinarum*, *Stauroneis anceps*, *Surirella linearis*, *Surirella robusta*, *Surirella splendida*, *Surirella tenera*, *Synedra rumpens*, *Synedra ulna* genera with wide range of community composition and species distribution across the river. Among all species (relative abundance >0.05% of all sites), *Achnanthes minutissima* Kutz., *Cyclotella meneghiniana* Kutz., *Cyclotella catenata* Brun., *Cymbella tumida* (Breb) Van Heurck, *Cymbella turgida* (Greg) Cleve, *Cymbella ventricosa* Kutz., *Fragilaria intermedia* Grun var. *robusta*, *Gomphonema lanceolatum* Ehr., *Gomphonema parvulum*, *Nitzschia sigma* (Kutz) W.Smith, *Nitzschia thermalis* Kutz v minor Hilse, *Nitzschia palea* (Kutz.) W. Smith, *Pleurosira salinarum* Grun, *Synedra ulna* (Nitzsch) Ehr were the most abundance species occurred. *Cyclotella meneghiniana* Kutz., *Gomphonema parvulum* and *Nitzschia palea* (Kutz.) W.Smith were the most abundance species occurred. These species were cosmopolitan which is reported from North America (Stevenson and Pan, 1999) Europe (Bella et al., 2007) & Africa (Facca and Sfriso, 2007) and well recognized diagonally inhabiting sensible to extremely polluted in the river. *Cyclotella meneghiniana*, a pollution tolerant species was abundant at Kumarapalaiyam, representing water quality as rich with ionic concentration. *Gomphonema parvulum* and *Nitzschia palea* with environmental characteristics of highly tolerant to nutrients and ions was abundant at Kumarapalaiyam South, which is having the highest Electrical conductivity and ionic concentrations. However Kalingarayan canal, unlike from rest of the river (low ionic level) was dominated by *Achnanthes minutissima* Kutz species which occurs in slightly to moderate waters. The Physicochemical analysis of river across 5 sampling sites is listed. The water chemistry differed across sampling sites. The Hydrogen ionic concentration (pH), Electric conductivity (EC), Biological oxygen demand (BOD), Chemical oxygen demand (COD) and alkalinity were the parameters showed marked difference among various samples. The Hydrogen ionic concentration (pH) ranged from 7.12 to 7.81, highest being 7.81 at Kumarapalaiyam south. Water temperature had a wide range, 24.00 to 27.80 (mean 25.86, SD 1.62) which mainly dependent on the time of sampling. Electric conductivity is varying much (mean 937.912, SD 336.1217) having low at Kuduthurai (404 ppm) and high value noticed

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at Kumarapalaiyam south (1223.33 ppm) which is beyond the permissible limits. High electric conductivity is mainly due to high ionic concentrations. Nutrients such as nitrates and phosphates varied from 0.01- 0.12 ppm and 0.002- 0.030 ppm respectively within the permissible limits. The alkalinity ranged from 110mg/L at Kuduthurai and high to 159.01 at Kumarapalaiyam south. Both Chemical oxygen demand (COD) and Biological oxygen demand (BOD) values were high at Angalamman temple (80.01mg/L, 13.80 mg/L) and low at Kuduthurai (10.65 mg/L, 2.92mg/L) respectively. Among 5 sample locations the Angalamman temple and Kumarapalaiyam south sites recorded with high ionic concentrations while low values within the permissible limit was recorded in Kalingarayancanal and Kuduthurai.

The Principal component analysis (PCA) indicated considerable movement away in water chemistry transversely river explaining 56.691% and 37.209% of the variance from 1st and 2nd component respectively (Figure 2). The Principal component analysis (PCA) formed 2 groups of highly polluted among sampling sites. Sampling sites Angalamman temple, Kumarapalaiyam and Kumarapalaiyam south were grouped to the right side along the component 1, characterized by higher concentrations of water temperature, Biological oxygen demand (BOD), Chemical oxygen demand (COD), Phosphate and Calcium. Kalingarayan canal and Kuduthurai were grouped along the component 2 with minimum influence of water chemistry. These were grouped separately showed Hydrogen ionic concentration (pH), Electrical conductivity (EC), Dissolved oxygen (DO) and magnesium effects of can be said as moderately or slightly polluted among sampling sites.

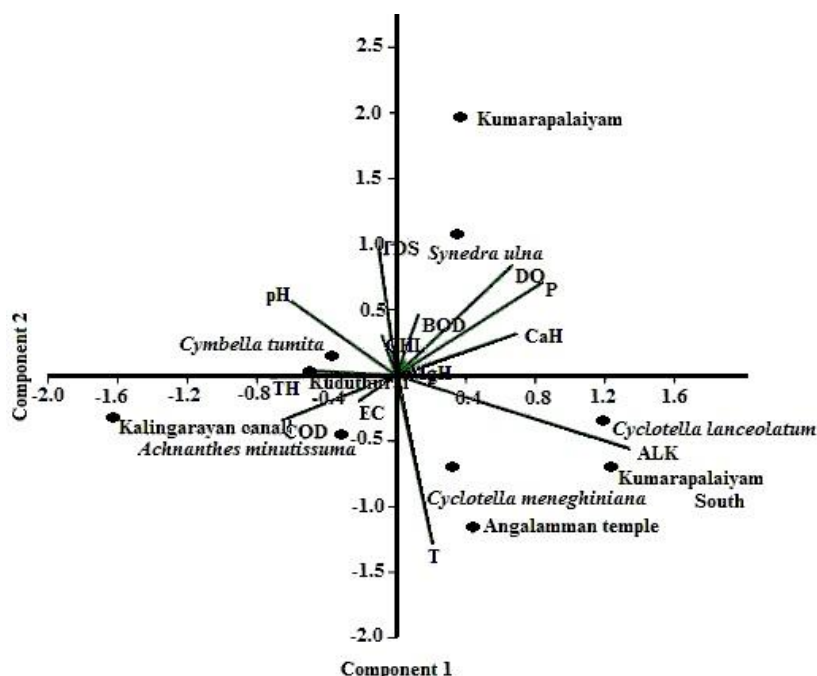


Figure 2: The Principal component analysis (PCA) diagram

The Detrended correspondence analysis (DCA) for diatom data indicated that communities differed clearly between the sampling stations. This plot shows diatom community composition and its relationship with varying environmental variables across sampling sites. The Eigenvalues of the first two axes for diatom Detrended correspondence analysis were 0.0175 and 0.01066. The first Detrended correspondence analysis axis summarized the distribution of the diatom communities throughout the conductivity and nutrient gradient of the moderately pollutes sites at the top of the plot. The Highly polluted sites were

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clustered on the bottom side of the axis with dominant tolerant taxa and corresponded to Angalamman temple, Kumarapalaiyam, Kumarapalaiyam south those sites located in densely populated and highly

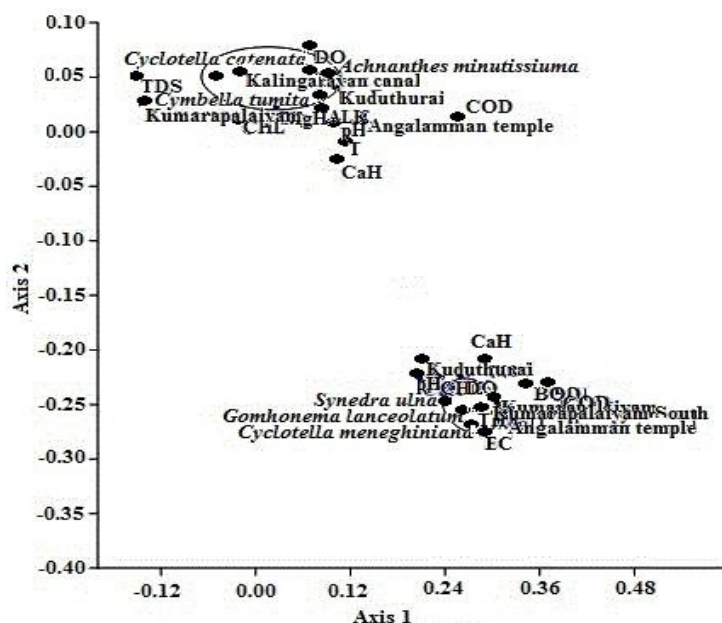


Figure 3: The Detrended correspondence analysis (DCA) diagram

industrialized (dyes factories) areas. Diatoms taxa showing maximum abundance of species like that *Cymbellameneghiniana*, *Gomphonema lanceolatum*, and *Synedra ulna* in these samples. Sites on the upper left side of the axis 2 corresponded to communities in moderate pollution, Kalingarayan canal (Figure 3) in this locations the most abundant species are *Achnanthes minutissima*Kutz, *Cyclotellancatenata*and *Cymbellatumida*. Kalingarayan Canal appeared the least influenced at it's slightly affected by local agricultural and domestic activities.

CONCLUSION

The environmental distinguishing of every diatom taxa in occurrence and distribution as community composition is significant at every sampling location. The significance of water quality difference among the sampling sites is expressed in Principal component analysis (PCA) gradient.The highly polluted sites are clearly separated from rest of the data. The Principal component analysis (PCA) and Detrended correspondence analysis (DCA) demonstrate that sampling sites Angalamman temple, Kumarapalaiyam and Kumarapalaiyam south were grouped to the component 1, characterized by highly polluted water that locations present the diatom species like *Cymbella meneghiniana*, *Gomphonema lanceolatum*, and *Synedra ulna*, pollution due to densely populated and highly industrialized (dyes factories). The two locations showed slight but important differences in diatom assemblages. Kalingarayan canal and Kuduthurai were grouped along the component 2 with slightly polluted water that locations present the species like *Achnanthesminutissima* Kutz, *Cyclotella catenata* and *Cymbella tumida* among sampling sites. Diatom taxa that were abundant in a number of sites and associated with good quality environmental variables were *Achnanthes minutissima* Kutz, *Cyclotella catenata* and *Cymbella tumida*.

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