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Thamarapararani River and its Present Sediment Nutrient Status

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Abstract:- Aquatic sediments are heterogeneous, dynamic and ;P:multicomponent chemical systems where continuous cycling and exchange of elements take place among water, biota and atmosphere. Sedimentology helps understanding the complex sediment water interaction process which is an environmentally critical aspect of study. Minor disturbances in the transporting agency have also affected the depositional processes which are imprinted in the deposited sediment. In the present investigation the present status of sediment nutrients like Organic Carbon, Nitrogen and Phosphorus and C:N, C:P , N:P ratios were analysed to find out the impact of anthropogens in this lotic system of Kanniyakumari district. It was observed that there was a surge in these nutrients and their corresponding ratios in the water samples taken from station 3 (Kuzhithurai area) of this river. This finding brings out the polluted nature of this important water body which need immediate attention.

Keywords:- *Sediments, Carbon, Nitrogen, Phosphorus, C:N, C:P, N: P.*

I. INTRODUCTION

Sediments are the soul units of earth's crust in aquatic environments. Sediments cores can be used to construct the history of contaminant inputs in the river. Bottom sediments comprise particles of varying size, shape and chemical composition that have been transported by water and air from the sites of their origin in a terrestrial environment and have been deposited on the river, lakes or ocean floor. According to Wilson, 1977, sediment composition of a particular locality is largely controlled by the composition of the source rock, climatic regime, hydrological conditions, land use and the time of transit. The particles transported in water get sorted out and deposited in different areas of water bodies. Variations in parameters such as colour, texture, organic matter content etc. occur due to geographical and geological origin, geochemistry, sediments are derived from the erosion of basin slopes but the immediate supply is derived from the river channel and bank while the bed load comes from the stream bed itself and is replaced by the erosion of river banks. Rivers are major transporting agents of dissolved and particulate matter from the continents (Martin and Meybeck, 1979) and about 10% of world's drainage basins of rivers account for discharge of more than 60% of sediments. Riverine inputs include naturally weathered products as well as man made materials that are transported both in dissolved and particulate phases (Shankerand Manjunatha,1994). River channels are conduits for the disposal of weathered products derived from their catchments. In many cases the rate of weathering and the rate of removal are in long term equilibrium (Reneau and Dietrich,1991). Sediment yield is sensitive to the degree of vegetation cover because of sheltering and binding effects that reduce splash erosion and surface rills.

The study on organic carbon in the sediment is of potential significance for the proper understanding of its flux in an aquatic ecosystem. The SOC in the bottom sediments are flavoured by the supply of organic matter in the overlying waters, rapid accumulation of fine grained organic matter and low oxygen content of bottom waters (Krishna *et al*., 2013). SOC is a reliable index of nutrient degradation and productivity of the water body (Anilakumary,2001).Nitrogen in the aquatic sediments is mainly derived from the death and decay of vegetation, domestic wastes and agricultural run off containing nitrogenous fertilizers. The nitrogen from the domestic waste is mainly in the form of organic nitrogen and 30%may be removed by primary sedimentation. The major form of nitrogen available to biota in aquatic ecosystems are nitrate and ammonia that are consumed for their growth which in turn get deposited in the sediments after their death and decay. Sediments are constant sinks for nitrate from overlying river water (Nadelland Trimmer,1996: Zhu and Li, 2018). In sediments inorganic nitrogen (ammonium compounds,nitrate and nitrite) can diffuse to the overlying water and adsorbed into sediments or denitrified and is influenced by salinity (Morbck*et al*.,1997). Phosphate buffering is a crucial phenomenon in the phosphate economy of the aquatic system (Carignanand Vaithiayanathan,1999). The distribution of total phosphorous depends on the hydrological features of the overlying water, texture and mineralogical composition of the sediment. Phosphorous stimulated biological processes in sediment and returns of the water body.

C:N ratio in the sediment is an effective tool in evaluation the nature and source of organic carbon. Phytoplankton, the major producers in an aquatic ecosystem exhibit a ratio of 7 to 9 (Kemp *et al.*,1977). Autochthonous matter and terrestrially derived material register a C:N ratio of 8.6 and 16.0 respectively (Koshy,2001).The C:N ratio is also useful in identifying the sediments containing excess nutrients (Satyanarayana*et* *al*.,1993). The N:P ratio is an effective measure to denote the origin and source of sedimentary phosphorous. It is used as an index of the extent of extraneous influence on productive water body. Panigrahy*et al*.(1999) opined that low N:P ratio denotes the bioavailability of nitrogen for plankton production and the growth of phytoplankton can be considered as nitrogen controlled. The leaching of phosphate and nitrogenous materials from agricultural run off, excessive use of soaps, detergents ,discharge of industrial effluents and domestic sewage after the N:P ratio in an aquatic environment . The C:P ratio is employed in the assessment of the pollution status of an aquatic system especially by domestic sewage. It denotes the quantity of carbonaceous and nitrogenous organic matter reaching the river from various sources. The C:P ratio can be used to estimate the extent of the degradation in the sinking of particulate material.

II. MATERIALS AND METHODS

The present investigation is systematic analysis of surficial sediment samples from five selected stations along the Thamaraparani river. Textural analysis of the sediment samples were carried out by drying the samples in hot air oven at 90° C for 6 hours followed by mechanical sieving and pipette analysis as describes by Krubein and Pettijohn (1938). Organic carbon content in the sediment was analysedtitrimetrically by chromic acid oxidation method (EI Wakeel and Riley, 1957). Total nitrogen content in the sediment samples were estimated by Kjedahl's method (Barnes, 1959). The estimation of total phosphorous in the sediment sample was performed by the method of Murphy and Riley (1962).

III. RESULTS AND DISCUSSION

Sediment texture plays a significant role in the association and distribution of organic matter and metals. The rate of sediment movement and its distribution with in the rivers is a function of sediment nature mainly grain size and density as well as flow characteristics like velocity and temperature. The seasonal data on the textural analysis of sediment samples from different stations of Thamaraparani river is presented in Table 1. The percentage of sand ranged from 83.12 to 70.13%, 90.35 to 84.65 and 94.82 to 98.22% during premonsoon, monsoon and postmonsoon respectively among the stations(Fig. 1). The slit content fluctuated from 1.17 to 9.06 %, 2.30 to10.9% and 1.67 to 13.70% during premonsoon, monsoon and postmonsoon (Fig 1). The seasonal variation in the clay fraction varied from 1.06 to 17.53 %, 4.74 to 12.51 and 5.16 to 14.73% during premonsoon, monsoon and postmonsoon(Fig. 1) respectively. The sediment at Stations 1 and 2 exhibited sandy nature during postmonsoon. The sediment at Station 3 was sandy loamy irrespective of the seasons while Station 4 and 5 was sandy during premonsoon and monsoon that changed to loamy sand during postmonsoon. Sand fraction was low at Stations 1 and 2 as compared to the rest of the stations. The grain size analysis of sediment along the river exhibited a definite spatial and temporal variation which in turn affected the rate of adsorption and accumulation of organic and inorganic materials of both autochthonous and allochthonous origin.

Monthly variation in the organic carbon content in surficial sediment samples at the five stations along the Thamaraparani river ranged from 1.79 mg/g ±0.45 and 34.50 mg/g± 0.56(Table 2) . The annual average values varied from 1.17 to 32.80 mg/g. The season wisevalues of organic carbon registered a minimum and maximum of 0.69 and 33.46 mg/g 1.17 and 26.82 and 1.39 and 28.28 mg/g during premonsoon, monsoon and postmonsoon respectively(Fig 2). The SOC content was high during premonsoon at all stations situated in the fresh water stretch of the river except at Stations 5 where the maximum was registered during monsoon. The concentration of SOC was high during monsoon at Station 4, whereas during postmonsoon at Station 5. Enormously high organic carbon content was exhibited during premonsoon at Stations 3 as compared to the rest of the stations. The monthwise data on the distribution of SOC did not establish any definite trend among stations. Considerable decrease in concentration was noticed in the distribution of organic carbon in the sediment during monsoon at Station 3. A noteworthy feature in the distribution of organic carbon along the entire stretch of the river was the low values recorded at the estuarine station5 as compared to the rest of the stations. The distribution of SOC exhibited significant variation among stations (d.f =9, F = 3,422198, p<.0.001) while the temporal variation remained insignificant. The accumulation of organic carbon in the sediments was enhanced by abundant supply of organic matter in overlying water and their rapid settling and adsorption onto the fine grained inorganic material. Higher values of SOC registered as Stations 5 during monsoon and postmonsoon may be due to the heavy rainfall and excessive terrigenous run off bringing considerable amount of organic matter. Similar increase was noticed during southwest monsoon by Sankaranarayananand Panampunnayil,1979. The adsorption of organic matter on to the fine grained sediment was noticed at most of the stations. Similar reports were available elsewhere (Koshy,2001: Krishna *et al*., 2013).

The monthwise data on total nitrogen content in the sediment of the Thamaraparani river fluctuated between 0.07 mg/g ± 0.05 - 1.69mg/g±0.45 during September 2016 and 1.60mg/g -2.39mg/g . The annual average recorded a maximum of 1.94 mg ±0.34and a minimum of 0.40 ±0.26 mg/g (Table 2). The seasonal average varied from 0.32 to 0.65 mg/g, 0.75 to 1.95 and 0.28 to 1.77 mg/g during premonsoon, monsoon, and postmonsoon respectively(Fig. 3). The concentration of sediment nitrogen registered high values during monsoon at all stations in the fresh water stretch of the river. The nitrogen content was recorded during postmonsoon at Station 3 followed the values recorded during monsoon situated upstream as well as Stations 5 downstream (estuarine zone). The distribution of total nitrogen in the sediment of the river showed significant spatial (d.f = 11, F = 5.351475, p <.. 1.32E-06) and monthwise (d.f = 9, F = 2.087977, p <. 0.037) variations while the seasonwise variation remained insignificant. The seasonal analysis of total sediment nitrogen failed to establish any significant statistical variation.Nitrogen in the aquatic sediments is mainly derived from the death and decay of vegetation, domestic wastes and agricultural run off containing nitrogenous fertilizers. The nitrogen from the domestic waste is mainly in the form of organic nitrogen and the major form of nitrogen available to biota in aquatic ecosystems are nitrate and ammonia that are consumed for their growth which in turn get deposited in the sediments after their death and decay.

The monthwise data on total phosphorous varied from 0.025m/g.±0.09 at Station 2 (December 2016) to 0.336 ±0.032 mg/g at Station 3 (March 2016). The annual average recorded a minimum of 0.068 ± 0.56mg/g and maximum of 0.301±0.16mg/g (Table 2). The seasonal average values ranged from 0.050 to 0.102 mg /g 0.086 to 0.197 mg/g and 0.072 to 0.178 mg/g during premonsoon, monsoon and postmonsoon respectively(Fig. 4). The total phosphorous in the sediment registered comparatively higher values during postmonsoon at all stations. The maximum phosphorous content was recorded during monsoon at stations 3 and at station 4 during premonsoon at Stations 3. Monthly analysis of total sediment phosphorous registered significant temporal variation (d.f. =11, F = 3.400878, p<0.0005) while the spatial variation remained insignificant. Phosphorous stimulated biological processes in sediment and returns of the water body. The phosphate exchange capacity between sediment and overlying water appeared to be related to the texture of the sediment (Reddy and Hariharan, 1986).Algal uptake to phosphate phosphorous can be balanced by phosphorous desorption from the bottom sediments thus enabling the sustained productivity of a stream (Ellis and Stanford,1988). Phosphorous also acts as a growth limiting material regulation the continuous adsorption and desorption by sediments and as a source and sink for phosphate in phosphorous cycle (Nair and Balchand, 1992).The concentration of sediment phosphorous increases as the river flow is high and sensitive to various environmental conditions like bottom oxygen depletion, pH and temperature (Mc Comb *et al* .,1998).Any increase in phosphorus concentrations above those naturally present can increase macrophyte and algal growth, enhance microbial breakdown of biomass and cause distinct diurnal fluctuations in dissolved oxygen (DO) concentrations which ultimately lead to the mortality of anoxic-sensitive species (AnneHowell, 2010: Ramesh *et al.*, 2015). Such eutrophication is one of the most serious problems associated with freshwater and is defined as the enrichment of environmental waters by anthropogenically sourced nutrients which often have adverse ecological and water resource impacts.

The monthwise data on the C:N ratio (Table 2) ranged from 0.98 during October 2016 at Station 4 to 143.79 during April at Station 3. The annual average values fluctuated between 2.70 and 132.53 at station 5 and 4 respectively. The seasonal average (Table 2) exhibited the highest value of 34.95 at station 4 and the lowest value of 1.34 at Station 1 both during premonsoon. The season wise distribution of the C:N ratio varied from1.34 to 34.95,2.40 to 10.25 and 3.07 to 12.33 during premonsoon, monsoon and postmonsoon at all stations located upstream (Stations 1 to 2), during postmonsoon (Stations 3 and 4)and during monsoon (Stations 3 and 4). The general distribution patterns of C:N ratio at majority of stations of the Thamaraparani river was monsoon<postmonsoon<premonsoon. The C:N ratio at the fresh water stretch of the river exhibited minimum values during monsoon. In general ,the C:N ratio showed significant monthwise variation (d.f + 1, F = 3.326608,p <…0.0006) while the seasonal and spatial variations remained insignificant. The increase in the C:N ratio during premonoon may be attributed to the low flow rate, accumulation of organic matter and high decomposition activity due to the changes in the physicochemical characteristics. The high C:N ratio during monsoon at Station 3 may be due to the combined effect of *in situ* production and high organic matter from land run off, poor in nitrogen along with the sandy nature of the sediment.

The monthly data on N:P ratio varied from 0.32 during October 2016 at Station 1 and 39.07 during June 2016 at Station 3 (Table 2). The annual average ranged from 3.41 to 7.31 at Stations 3 and 5 respectively. The computation of seasonal average values of N:P ratio registered a minimum of 1.99 during postmonsoon at Stations 2 and a maximum of 11.83 during monsoon at Station 4. The seasonal average fluctuated from 5.08 to 7.97, 13.29 to 21.83,1.99 to 5.82 during premonsoon, monsoon and postmonsoon respectively. The N:P ratio showed a distribution pattern of postmonsoon<premonsoon<monsoon at all stations. The N:P ratio registered significant monthwise (d.f = 10, F = 3.213252, p < 0.001) and seasonwise (d.f +1, F =5.474.11,p<…0.047) variation while the spatial variation remained insignificant. The month wise data on C:P ratio (Table …..) in the surficial sediments of the Thamaraparani river registered a maximum of 907.41 during March 2016 at Station 4 and a minimum of 1.89 during October 2016 at Station 1. The annual average fluctuated between 15.08 at Station 10 and 66.92 at Station 5. The seasonal data on the C:P ratio varied from 9.89 to 180.00, 15.20 to 55.99 and 15.05 to 60.68 during premonsoon, monsoon and postmonsoon respectively.Prasanthanand Nayar ,2000, and Koshy,2001 from 0.22 also agrees with the values of C:P ratio of the present investigation.

The present work was able to throw light into the less documented sedimentological nutrient levels of the river. The findings agrees the polluted nature of the above water from anthropogenic impact. The indiscriminate sand mining has also contributed to the depletion of sediments making way for less productivity in terms of fish landings. Hence it is the need of the hour to give prime importance to this lotic system which is a major water source of the people of Kanniyakumari district of Tamil Nadu by involving Government officials, NGOs and the student community so as to preserve this wealth of the nation for the future.

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	Sand (%)	**Silt (%)**	**Clay (%)**
Stations			
1	**86.12**	**5.58**	**1.07**
2	**92.36**	**4.89**	**4.46**
3	**97.76**	**8.02**	**12.31**
4	**96.73**	**10.89**	**14.73**
5	**95.77**	**14.56**	**16.76**

Table 1:- Showing the Textural Details of the Sediments from the Different Stations of Thamaraparani River Stretch in Kaniyakumari District
Mean are the averages of five replicates

	Carbon Content (mg/gm)	**Nitrogen Content (mg/gm)**	**Phosphorus Content (mg/gm)**
Months			
Jan 2016	**16.32±0.01**	**0.43±0.62**	**0.068±0.56**
Feb 2016	**25.48±0.54**	**0.60±0.21**	**0.032±0.46**
Mar 2016	**34.50 ±0.56**	**0.82±0.32**	**0.078±0.12**
Apr 2016	**13.96±0.69**	**0.94±0.83**	**0.13±0.54**
May 2016	**1.79 ±0.45**	**1.06±0.67**	**0.19±0.46**
Jun 2016	**12.34±0.32**	**1.78±0.45**	**0.25±0.61**
Jul 2016	**19.02±0.18**	**1.34±0.03**	**0.34±0.49**
Aug 2016	**24.92±0.08**	**0.72±0.23**	**0.26±0.51**
Sep 2016	**32.67±0.44**	**1.31±0.67**	**0.32±0.16**
Oct 2016	**11.78±0.17**	**1.94±0.07**	**0.24±0.46**
Nov 2016	**4.98±0.37**	**1.25±0.23**	**0.16±0.21**
Dec 2016	**14.77±0.28**	**0.27±0.43**	**0.07±0.11**

Table 2:- Annual Average of the Nutrients from the Sediments Samples of Thamaraparani River Stretch in Kaniyakumari District
Mean are the averages of five replicates ± SE

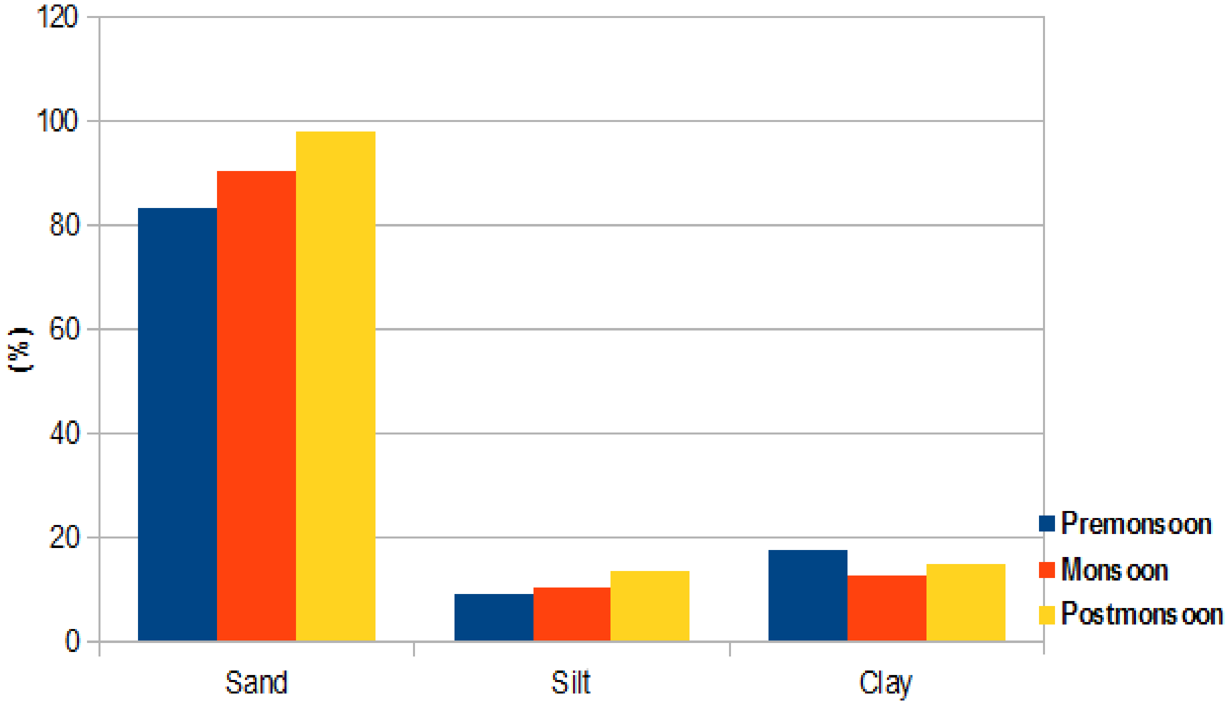

Fig 1:- Sediment Textural Analysis during Stages of Monsoon

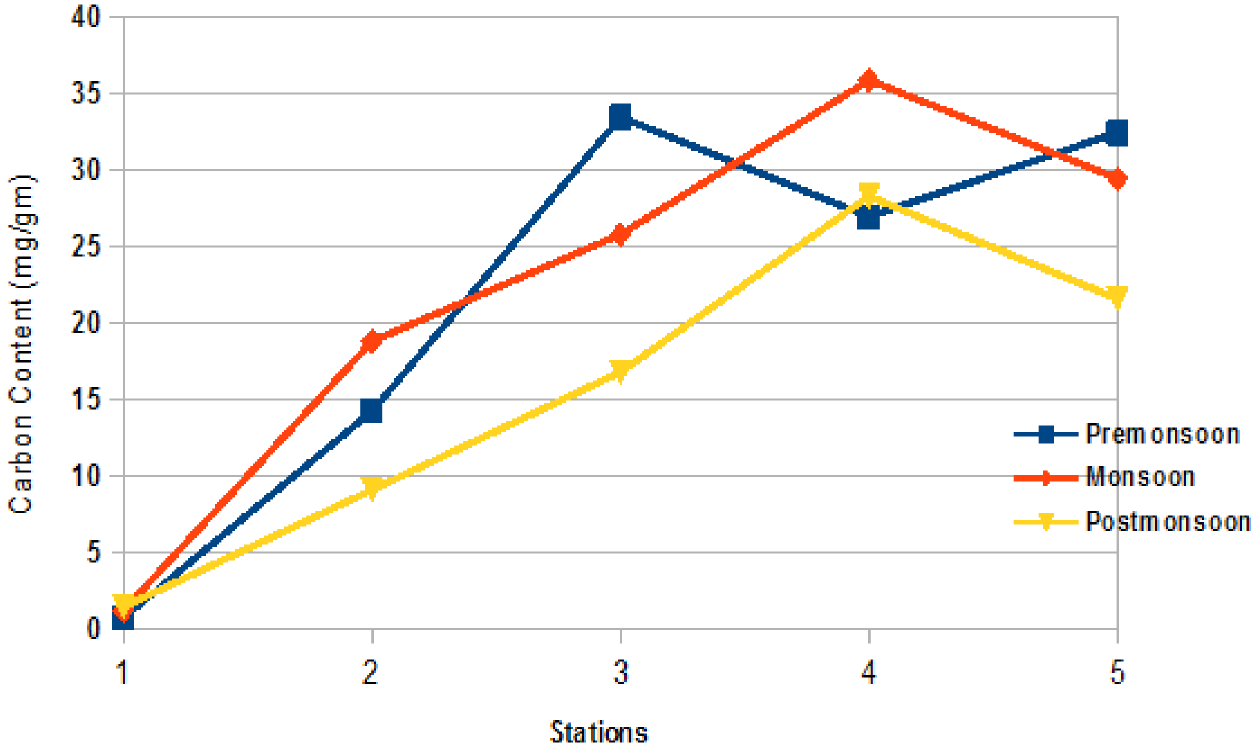

Fig 2:- Sediment Organic Carbon Levels in the Samples from Different Stations

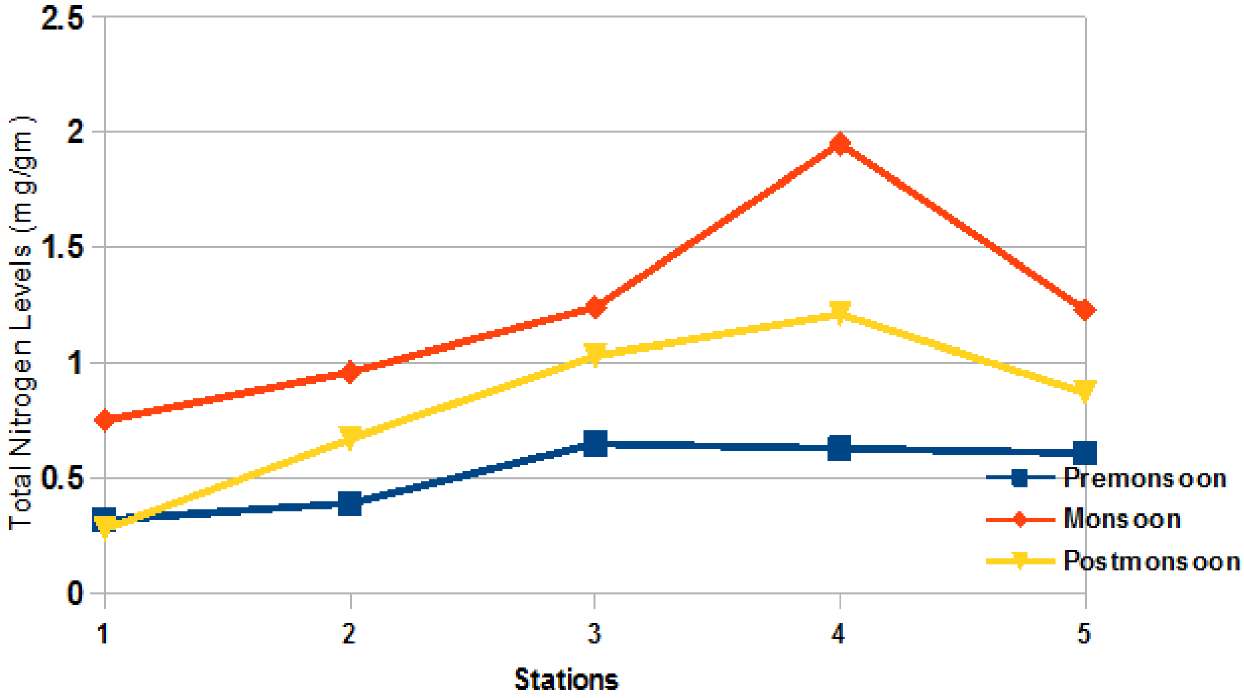

Fig 3:- Total Nitrogen Levels in the Sediments from Different Stations of the River

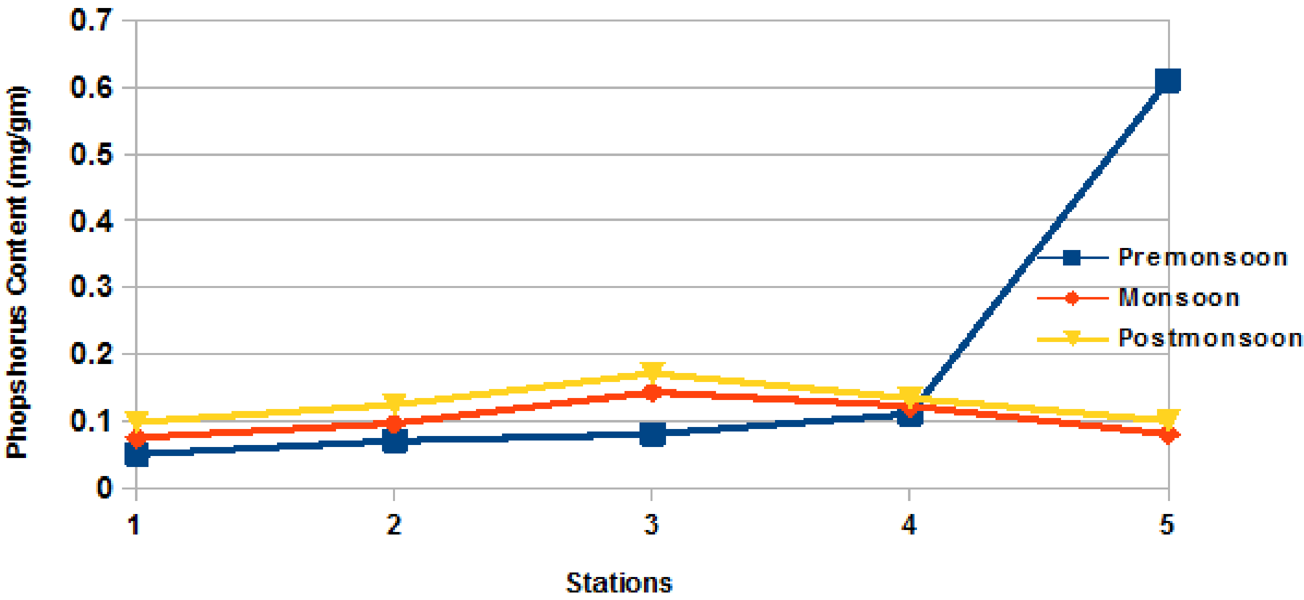

Fig 4:- Phosphorus Content in the Sedimnets from Different Stations of the River