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Research paper

Physico-Chemical Characteristics of Sediment Quality in Srirangam sub watershed of Tiruchirappalli District of Tamilnadu

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Abstract

A study of River Cauvery of Srirangam sub-watershed was conducted to evaluate the physico-chemical Parameters of the sediments for pre-monsoon, monsoon and post monsoon period of 2013-14, in order to check the impacts of agricultural runoff, effluents coming from watershed area on the river sediments at seven different sites in River Cauvery of Srirangam stretch. The results revealed that the average physico – chemical parameter values are more in pre-monsoon period and EC,Cl, Total Organic Matter, Phosphate, Total Nitrogen, Sodium and Potassium values are comparatively less in post-monsoon period. The concentration of trace metals chromium and zinc are more in both the seasons. This is the result of discharge of domestic, municipal and agricultural discharge in the stretch.

Keywords*: physico-chemical parameters, Effluents, sediment Quality, Agricultural run-off, Municipal Solid Waste..*

1. Introduction

Sediment (sometimes called "silt" or "alluvium") is comprised of solid particles of mineral and organic material that are transported by water. In river systems the amount of sediment transported is controlled by both the transport capacity of the flow and the supply of sediment [15]. The "suspended sediment load" refers to the fine sediment that is carried in suspension and this can comprise material picked up from the bed of the river (suspended bed material) and material washed into the river from the surrounding land (wash load). The wash load is usually finer than the suspended bed material. In contrast, the "bed load" comprises larger sediment particles that are transported on the bed of the river by rolling, sliding or siltation. Most rivers will transport sediment in each of these „load" forms, according to the flow conditions.

2.Sediment is a pollutant in its own right. Even where sediment is uncontaminated by agricultural fertilizers and pesticides and industrial or human waste, they cause turbidity in the water which limits light penetration and prohibits healthy plant growth on the river bed. The accumulation of sediments on the river bed can smother or disrupt aquatic ecosystems by reducing food sources, and degrading spawning grounds (such as gravel and rocky environments) and the habitats of desirable fish species. Turbidity may also result in eutrophication where nutrient rich sediments are present (particularly sediments from agricultural land with high fertilizer contents). Eutrophication creates a situation where the oxygen present in the water system is reduced to the point where fish species may be unable to survive in the water column. Eutrophication, where it results from toxic algal blooms, can also be a serious risk to human health. Sediments in areas with high human activity often contain chemical pollutants which may pose a risk to human health and the health of surrounding ecosystems. Potable water supplies can be compromised by the presence of excess sediment (whether contaminated by toxins or not) as purification facilities may not be able to cope with the sediment in the water – leading to temporary breakdowns and subsequent risks to the safety of the drinking water. Contaminated surface waters also risk altering the metabolic processes of the aquatic species that they host. These alterations can lead to fish kills or alter the balance of populations present. Other specific impacts are on animal reproducing, spawning, egg and larvae viability, juvenile survival and plant productivity [4][15].

2. Study Area

Seven sampling station of Srirangam stretch of river Cauvery of every kilometers of seven kilometers were selected. These locations were selected based upon the pollution sources like population density, agricultural activities, discharge of city sewage, festival activities and human interference etc.[17].

2.1 Materials and Methods

The sediment samples were collected from seven locations in the srirangam stretch of river Cauvery during the pre-monsoon (June 2013) and Post-monsoon (December 2013) season to predict the influence of runoff from river basin. Sediment samples were collected at 15cm depth of the river bottom and transferred to the laboratory in polythene bags. The sediment samples were air dried for room temperature for seven days and homogenized into fine particles using an agate mortar and pistil and sieved through 63 micron mesh sieve [13]. The physico-chemical parameters like pH, Electrical Conductivity, Alkalinity, chloride, Total organic matter, phosphate, total nitrogen, sodium and potassium were determined

and compare the result with standards [5][17]. The particles with less than 63micron were taken for heavy metal analysis like Cd, Cr, Cu, Pb, and Zn. Sediment samples were digested using microwave digestive system using mixed acid digestion technique as prescribed by APHA[1][2].Extracts were analyzed by atomic absorption spectrophotometer.

3. Results and Discussion

The results of the physical and chemical parameters of Srirangam sub-watershed of pre-monsoon and post-monsoon periods are presented in Table 1 and Table 2.

3.1. pH

The pH value is having a large scale importance in water supply system. It controls water as well as sewage treatment processes like coagulation, Disinfection, Water softening, etc., The principal component regulating ion pH in natural waters is the carbonate, which comprises Co_2, H_2CO_3 and HCO_3[14][17].The distribution in pH clearly showed that the waters have no or very slight Alkalinity in both the seasons which one is permissible limit prescribed by standards like BIS and WHO except the site S1, which is slightly influenced by acidic value of 6.9 in pre-monsoon season.

3.2. Electrical Conductivity

Electrical conductance is a good measure of dissolved solids. Conductivity is a measurement used to determine mineralization of water. Certain physiological effects on plants and animals are often affected by the number of available ions in the water [14]. In the present investigation, the mean value of Electrical conductivity value in the range of 86 µS/cm to 620 µS/cm in pre-monsoon period and 101 µS/cm to 723 µS/cm in post monsoon season. The highest value found in site 6 and site 7. Water in this region was found to be stagnant due to form of depression and also confluence of residential discharge of waste water.

3.3. Alkalinity

Alkalinity is a measure of its capacity to neutralize acids, i.e. to absorb hydrogen ions, without significant pH change. This is due to presence of hydroxides (OH^-), carbonates (CO_3^{--}) and bicarbonates (HCO_3^-). Presence of carbonate and bicarbonate in water is an interchangeable process, and dependence upon the pH value of water [14]. In the present investigation, total alkalinity mean value ranged from 27.70 mg/liter and 18.80 mg/liter in pre-monsoon and post-monsoon season. Total alkalinity observed in the present study is well within the prescribed standards of drinking water (> 20 mg/liter).

3.4. Total Organic Matter

Organic matter in sediment consists of carbon and nutrients in the form of carbohydrates, proteins, fats and nucleic acids. Bacteria quickly eat the less resistant molecules, such as the nucleic acids and many of the proteins. Sediment organic matter is derived from plant and animal detritus, bacteria or plankton formed in situ, or derived from natural and anthropogenic sources in catchments [21]. Sewage and effluent from food-processing plants, pulp and paper mills and fish-farms are examples of organic-rich wastes of human origin. The total organic matter content observed in the present study is 0.90% and 0.24% in pre-monsoon and post-monsoon seasons. The highest value of organic matter was found in site 1, 5 and 7 in pre-monsoon period.

3.5. Phosphate

The main environmental impact associated with phosphate pollution is Eutropication [18]. Phosphate content observed in the present study is 0.026% and 0.032% in pre-monsoon and post-monsoon periods respectively. This indicated that the phosphate bearings contaminants get accumulated in site 6 in both the season. This reveals that localized mode of contamination in the river.

3.6. Total Nitrogen

Total Nitrogen is an essential nutrient for plants and animals. However, an excess amount of nitrogen in water may lead to low levels of dissolved oxygen and negatively alter various plant life and organisms. Sources of nitrogen includes wastewater treatment plants, runoff from fertilized lawns and crop lands, failing septic systems runoff from animal manure and industrial discharges that contain corrosion inhibitors[22]. This study revels that Total nitrogen concentration in sediments showed a slight increase in post-monsoon period possibly due to addition of nitrogenous pollutants through the runoff water. The mean values of pre-monsoon and post-monsoon season are 0.20% and 0.24% respectively site 3 has more pollutant than any other site in both the season.

3.7. Sodium

Sodium is a soft, silvery-white, highly reactive metal that is never found in nature in the uncombined state. Sodium, an alkali-metal element, has a strong tendency to exist in the ionic form [7]. The mean values of pre-monsoon and post-monsoon season of sodium are 0.017% and 0.019% respectively which one is with in the limit of WHO standards.

3.8. Potassium

Available K in all the sites ranges from 0.001 to 0.010 mg/kg during pre-monsoon and 0.002 to 0.013 mg/kg in post-monsoon period. At most of the sites there are significant differences in available potassium recorded. The higher concentration of available potassium found at site 6 in pre-monsoon and lower concentration is found at site 4 in pre-monsoon.

3.9. Cadmium

Cadmium (Cd) is the most harmful of all the heavy metal pollutants. Cadmium as a water pollutant should be given more weight age since it causes several adverse damaging effects on human body through its accumulation. Cadmium is contributed to the surface waters and sediments through paints, pigments, glass enamel, deterioration of the galvanized pipes etc. The main source responsible for cadmium concentration is anthropogenic activities [3][8].The distribution of cadmium in the study area varied between 0.6 to 3.59 mg/kg during pre-monsoon and 0.74 to 1.29 mg/kg in post-monsoon period. In most of the site there is no significant difference in available cadmium recorded except site 6 in both the season, this may due to more anthropogenic activities.

3.10. Chromium

Trace metal concentration of surface water depends not only on industrial and household waste inputs but also on the geochemical composition of the area. The mining and mineral processing activities probably accountant for Cr concentration [8][18]. They contended that the enrichment of Cr at high levels in particulate matter might be due to the domestic and industrial waste inputs. In the present study, the concentration of Cr level was more in 35.79 mg/kg in site 6 in pre-monsoon season and 26.66 mg/kg and 27.66 mg/kg in site 3 and site 7 respectively in post-monsoon season.

3.11. Copper

Copper is found in association with many other metals and deposit styles. Commonly, copper is either formed within sedimentary rocks, or associated with igneous rocks. Sedimentary copper forms within ocean basins insedimentary rocks. Generally this forms by brine from deeply buried sediments discharging into the deep sea, and precipitating copper and often lead and zinc sulfides directly onto the sea floor. This is then buried by further sediment. This is a process similar to SEDEX zinc and lead, although some carbonate-hosted examples exist [7][8]. In the present study, the concentration of Cu level was more 15.04 mg/kg in site 1 in pre-monsoon season and 26.66 mg/kg and 11.78 mg/kg in site 7 in post-monsoon season.

3.12. Lead

Lead (Pb) is naturally present in the environment. The high level of Pb in sediments could be attributed to the industrial and agricultural discharge [7][8]. Higher levels of Pb often occur in water bodies near high ways and large cities due to high gasoline combustion. The Pb concentration in sediment was found to be between 2.30 mg/kg to 11.20 mg/kg in pre-monsoon season and 1.32 mg/kg to 5.28 mg/kg on post-monsoon season. In site 1, the maximum Pb concentration was found to be 11.20 mg/kg in pre-monsoon season. In the absence of major industrial activity, high concentration of Pb can also be attributed predominantly to infuse from upper catchment area the contribution from domestic waste discharges appear to be insignificant.

3.13 Zinc

Zinc (Zn) is the essential minerals for humans, plants, animals and micro organism. They can accumulate considerable amount of zinc in their system without any damaging effects. Zinc does not from a serous pollution problem [8]. The zinc level of sediments in inspected sites ranged between 1.10 mg/kg to 18.54 mg/kg in pre-monsoon season and 1.69 mg/kg to 11.78 mg/kg in post-monsoon season. In the present study, the concentration of Zn level was more 18.54 mg/kg in site 1 in pre-monsoon season and 11.78 mg/kg in site 7 in post-monsoon season.

Table 1: Physico-Chemical Characteristics of Sediments of Pre-monsoon Season

Parameter	**Unit**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Mean ±SD**
pH		6.9	9.0	8.5	8.59	8.70	8.12	8.53	8.53±0.68
Electrical Conductivity	µS/cm	279	260	420	86	204	403	620	279±173
Alkalinity	Mg/liter	29.0	26.0	28.05	27.70	25.00	28.00	27.48	27.70±1.36
Chloride	%	0.032	0.037	0.019	0.014	0.026	0.023	0.020	0.023±0.008
Total organic Matter	%	1.57	0.60	0.80	0.70	1.20	.90	1.40	0.9±0.37
Phosphate	%	0.020	0.026	0.031	0.021	0.014	0.034	0.035	0.026±.008
Total Nitrogen	%	0.3	0.19	0.20	0.20	0.18	0.20	0.20	0.2±0.040
Sodium	%	0.020	0.024	0.017	0.003	0.015	0.015	0.017	.017±0.006
Potassium	%	0.005	0.005	0.008	0.001	0.004	0.010	0.008	0.005±0.003
Cd	mg/kg	1.59	0.92	0.98	1.12	0.60	3.59	1.17	1.42±0.93
Cr	mg/kg	20.36	11.74	11.17	14.62	7.03	35.79	12.75	16.2±8.82
Cu	mg/kg	15.04	2.18	4.19	4.14	2.20	7.96	3.88	5.66±4.22
Pb	mg/kg	11.20	8.60	8.00	8.30	3.40	4.30	2.30	6.58±3.02
Zn	mg/kg	18.54	6.82	13.75	1.94	1.10	11.81	4.84	8.37±5.97

Table 2: Physico-Chemical Characteristics of Sediments of post-monsoon Season

Parameter	Unit	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Mean ±SD
pH		8.0	8.5	8.0	8.90	8.40	8.63	8.0	8.4±0.36
Electrical Conductivity	µS/cm	326	303	490	101	238	470	723	326±201
Alkalinity		19.00	17.10	23.00	19.00	17.0	18.80	17.90	18.8±2.02
Chloride	%	0.043	0.050	0.026	0.019	0.035	0.030	0.027	0.03±0.010
Total organic Matter	%	0.18	0.24	0.19	0.38	0.22	0.25	0.35	0.24±0.078
Phosphate	%	0.024	0.032	0.038	0.026	0.018	0.042	0.043	0.032±.009
Total Nitrogen	%	0.4	0.22	0.33	0.25	0.20	0.20	0.24	0.24±0.074
Sodium	%	0.022	0.027	0.019	0.003	0.018	0.018	0.019	0.019±0.007
Potassium	%	0.006	0.006	0.010	0.002	0.005	0.013	0.010	0.006±0.003
Concentration of Trace Metals									
Cd	mg/kg	1.29	0.81	0.74	1.02	BDL	2.84	0.89	1.27±0.73
Cr	mg/kg	13.86	12.78	26.66	11.64	12.65	11.71	27.66	16.71±6.65
Cu	mg/kg	2.29	1.21	1.93	0.49	0.24	0.14	2.28	1.23±0.85
Pb	mg/kg	1.32	5.28	BDL	1.56	BDL	1.92	BDL	2.52±1.60
Zn	mg/kg	1.69	5.21	8.35	BDL	3.12	BDL	11.78	6.03±3.64

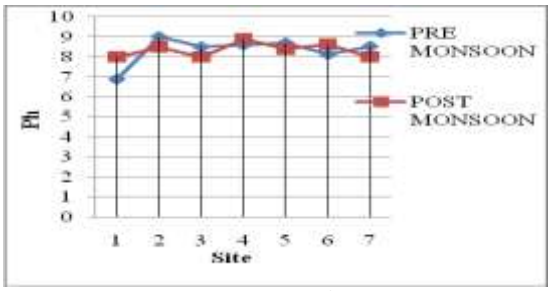

Fig 1: Seasonal variation of pH

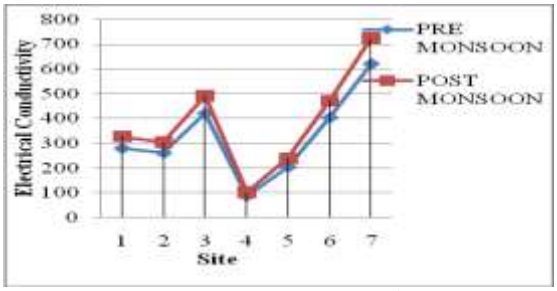

Fig 2: Seasonal variation of EC

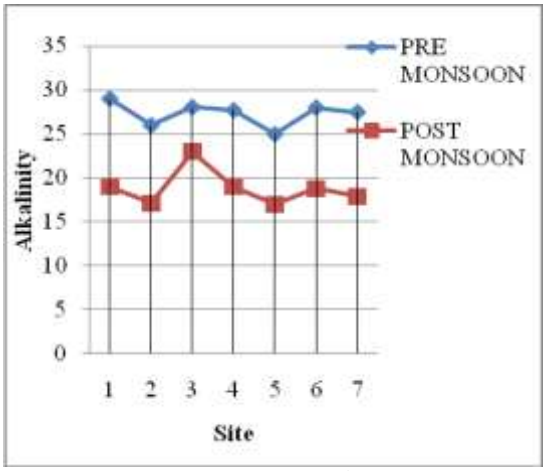

Fig 3: Seasonal variation of alkalinity

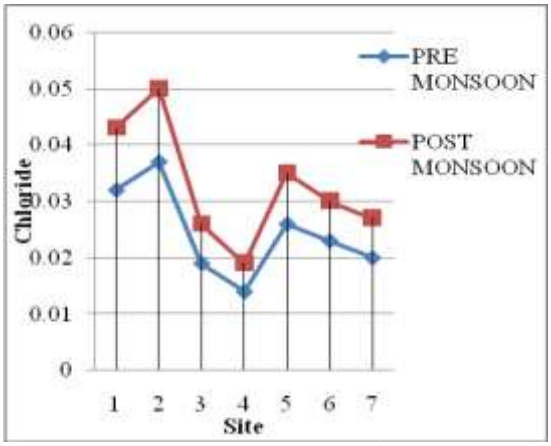

Fig 4: Seasonal variation of Cl

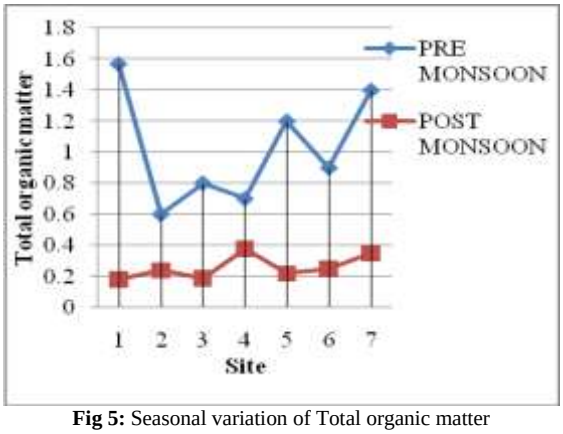

Fig 5: Seasonal variation of Total organic matter

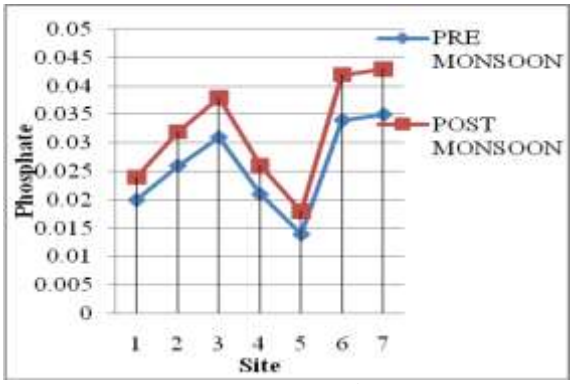

Fig 6: Seasonal variation of Phosphate

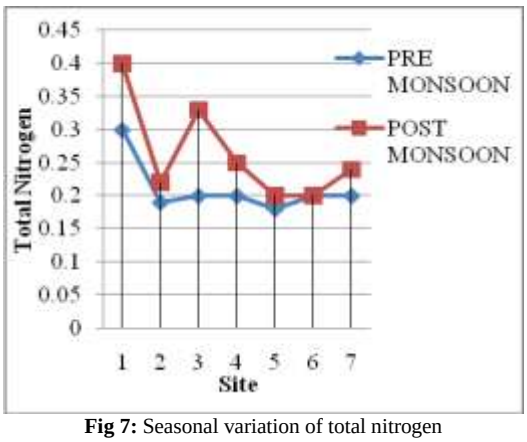

Fig 7: Seasonal variation of total nitrogen

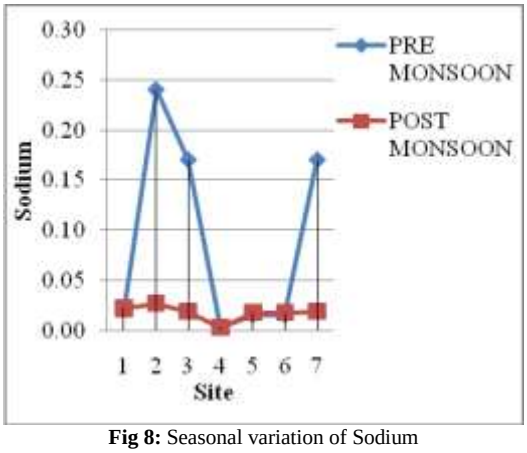

Fig 8: Seasonal variation of Sodium

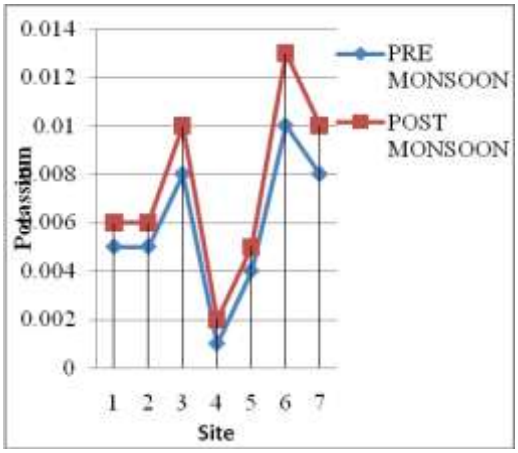

Fig 9: Seasonal variation of K

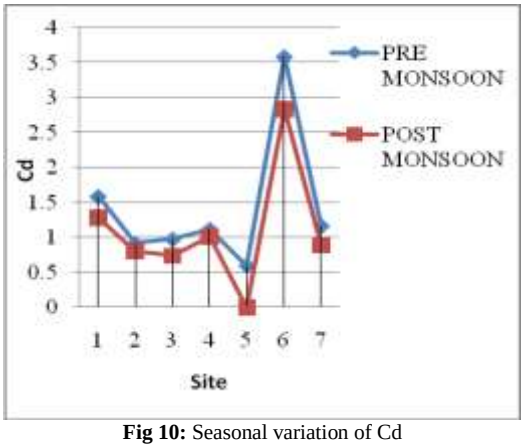

Fig 10: Seasonal variation of Cd

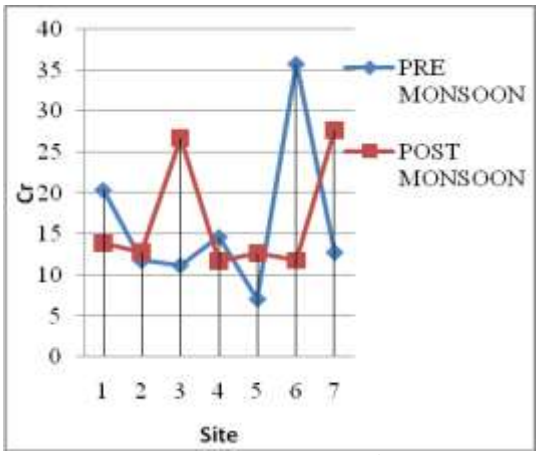

Fig 11: Seasonal variation of Cr

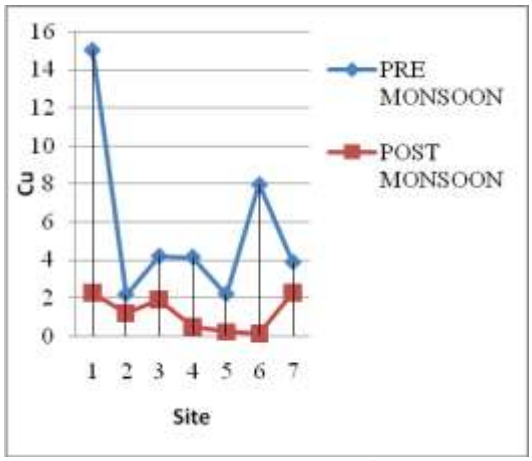

Fig 12: Seasonal variation of Cu

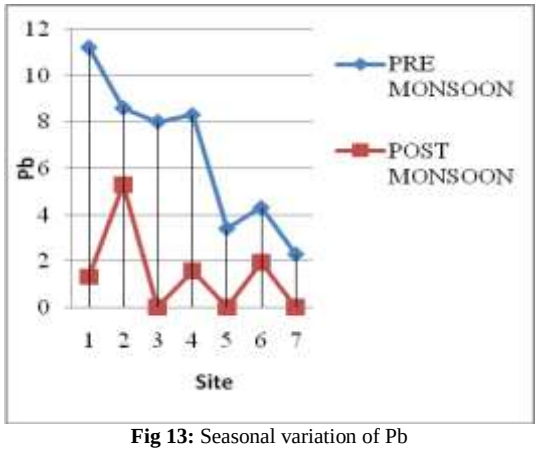

Fig 13: Seasonal variation of Pb

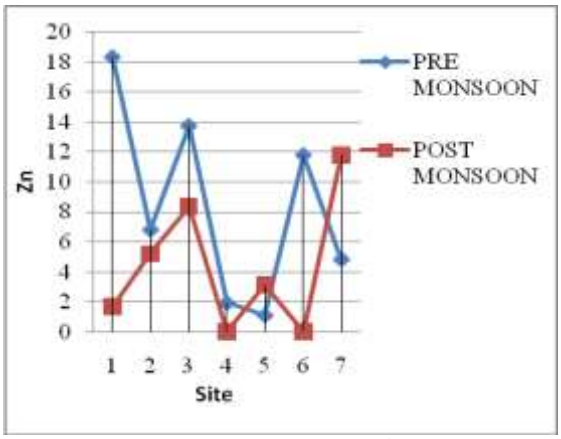

Fig 14: Seasonal variation of Zn

4. Conclusion

Physico - chemical characteristic of sediment quality in Srirangam sub watershed of Tiruchirappalli is not varied according to season except pH in site 1 shows acidic in pre-monsoon period and the remaining sites show alkalinity in both the season. pH of water matching according to the standard prescribed by WHO, ICMAR and BIS. Electrical conductivity of site 6 & 7 found in highest value in both the season due to stagnation of water and discharge of residential and agricultural effluent. There is no significant harmful waste in chloride, total organic matter, potassium and total nitrogen in both the season. Phosphate concentration is more in site 7 in both the season; this is due to localized mode of contamination in the river. Sodium concentration is comparatively more in Site 2 in both the season this is due discharge of agricultural waste. This study reveals the concentration of trace metals found in the Cr > Zn > Pb > Cu > Cd in pre-monsoon period and Cr > Zn > Pd > Cd > Cu in post-monsoon period, which shows that chromium and zinc dominated among the remaining metals lead, cadmium and copper. This is due to domestic, municipal and agricultural discharge more in this site. This study also reveals that variation according to season did not adhere to any specific trends and did not match with any previous studies. This may due to investigation of short distance and duration.

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