RISK ASSESSMENT OF POLLUTANTS DEPOSIT IN RIVER MUSI AND IN IT'S ENVIRONMENT

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Abstract: *The area under the Musi river basin is severely affected by the heavy metal contamination. This River originates in Ranga Reddy district and contributes to the flow of drinking water reservoirs viz. Osman Sagar and Himayat Sagar, the latter through its tributary, the 'Musi' for the city of Hyderabad. The information on the influence of sewage water on soil, water and food chain for this region is restricted to research stations only. Therefore, with this background, the present research work was undertaken in the farmer's field to study the extent and magnitude of micronutrients and heavy metal contamination in soil due to irrigation with sewage water over years. To study the content of heavy metals in leafy vegetables and fodder crops raised under sewage irrigated conditions with reference to standard safe limits and to establish the relationship of soil content of micronutrients and heavy metals with their respective plant concentration.*

Key words: Musi, Heavy metals, Risk analysis studies

1.0 Introduction

There are 12 industrial areas within 30 km of Hyderabad city, which include electroplating, oil mills, lead extraction battery units, pharmaceuticals, leather, textile, paper etc. The common effluent treatment plant (CETP), which was established for the industrial areas, is not able to treat the effluents adequately due to their complex nature and the lack of adequate pre-treatment facilities at the individual industrial facilities. The CETP discharges to the STP at Amberpet, which subsequently discharges into the Musi River without further treatment. Individual industries that do not send their effluents to the CETP also discharge directly into the Musi River. Organic pollutants in the river are partially eliminated by self-purification and accessible dilution. The inorganic pollutants (heavy metals) are the fraction of greatest concern due to their persistence in sewage sludge, which later becomes a potential source of risk to the nearby soils and vegetation. Episodes of heavy metal pollution of the Musi River and its surroundings have been reported (Buechler et al. 1999; Kumari et al. 1991; Venkateshwarulu and Kumar 1982; Bansal 1998). Along the banks of the Musi intensive cultivation of fodder grass (para grass) and food crops occurs in the sewage sludge, and the concentrations of heavy metals are reported to be very high (Kumari et al. 1991; Venkateshwarulu and Kumar 1982; Bansal 1998; Anjaneyulu 2001). Grass raised along the river is the fodder for most of the cattle in and around Hyderabad (Buechler et al. 1999; Sircar 2000). Because of these conditions, a methodical study was conducted to assess heavy metal concentrations in different environmental matrices and also to understand the potential risk to animals and humans due to heavy metal exposures through the food chain.

The rainfall recorded during the study period is shown in Fig. The temperature variation pattern in the study area supports the flow variation. The maximum temperature 40-42 ^{0}C in the study area is recorded during the month of May and the minimum 10-12 ^{0}C during the month of December. The other months of the year are dry without rainfall or with few occasional showers.

2.0 Objective

To do the risk assessment of pollutants on environment.

To study the rainfall influence on water quality in the study area.

To study the seasonal variations effect on the concentration of pollutants.

To study the heavy metals in fodder grass and milk.

3.0 Study area

Investigations of Pollutants concentrations were conducted along and across the Musi River basin from Osmansager lake (upstream) Himayath Sager lake (upstream) Nagole (middle stream) Peerjadiguda (middle stream) Pratap singaram (down stream),Amberpet Bridge Nallachervu , including 2 km on either side of the river.

4.0 Methodology

Reagents all chemicals used were of analytical reagent grade. All solutions were prepared in deionized water (zero metal concentration). Calibration standards for each metal were prepared by appropriate dilution of stock solution of 1,000 ppm of J.T. Baker/E. Merck standards.

Measurements of metal contents

Concentrations of Zn, Cu, Cr, Ni, Pb, As, Hg, Cd, and Co were measured in milk and vegetation (fodder grass) sequentially extracted fractions by Ultra Mass 700 ICP-MS (Varian, Australia). Mathematical equations that were built into the software (Jarvis and Gray 1992) were used for isobaric interference corrections. Canadian reference standards CANMET SO-1, SO-2 and SO-4 and NIST (USA) water CRMs 1643b, 1643c, and 1643d were used to confirm the accuracy of the analytical data. A 10% Rhodium solution of 1 mg/L concentration was added to all samples such as vegetation, milk, as an internal standard (Balaram et al. 1992). Inter-laboratory testing was performed on all samples by ICP-OES (Jobin Yvon Ultima, France at Defence Metallurgical Research Laboratory, Hyderabad) and FAAS (SpectrAA 500, Varian at National Geophysical Research Institute, Hyderabad). The values reported per sample are an average of nine readings consisting of the three different instrumental techniques. Recovery values in the range of ±2% were accepted, otherwise analyses were repeated. For QA/QC of vegetation, and milk, due to the non-availability of CRMs in our laboratory, recovery studies were conducted using standard additions.

5.0 Results and discussions

Rainfall significantly influences the water quality especially during the first flush and later the dilution effect leads to reduction the concentration of the pollutant. Especially in rivers draining urban catchments, rainfall can significantly affect the water quality. Also in dry season, the wastewater inflows can degrade the water quality of the river mainly because the discharge in the river is low and the dilution ratio is insignificant

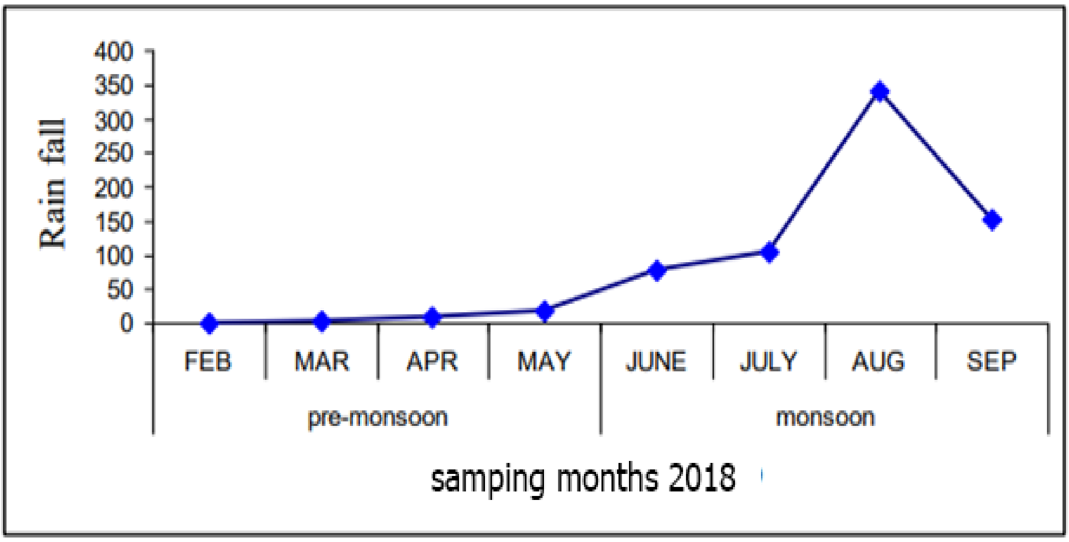


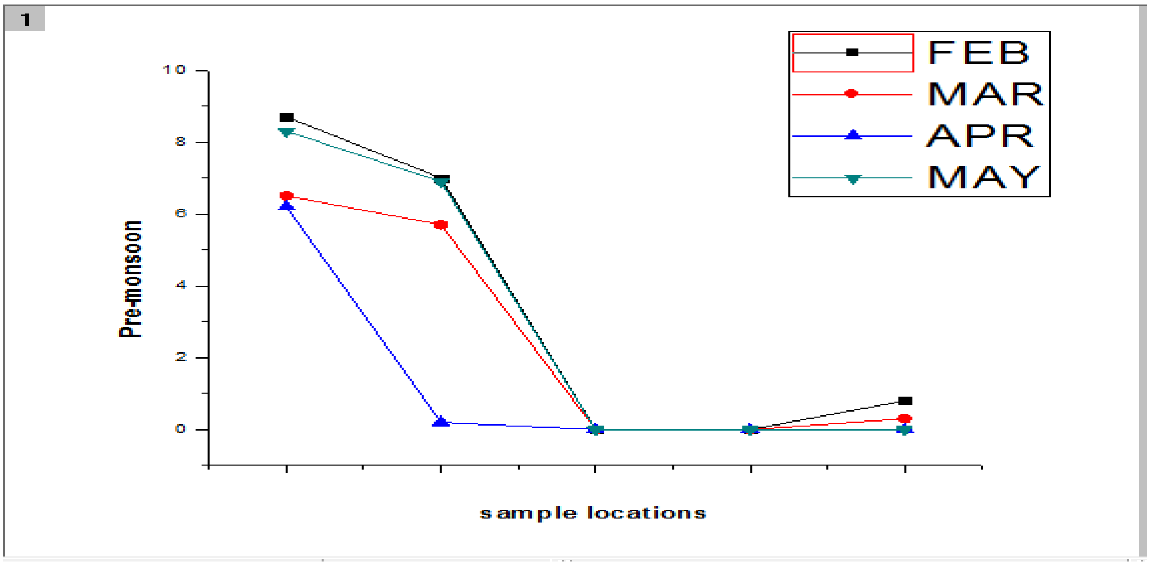
Figure: 5.1 Rainfall distribution in the river Musi during 2018

Dissolved Oxygen levels in water indicate the status of water quality. DO, however vary with temperature and saturation DO levels in water indicate zero pollution. The Do levels recorded during the study are presented in Table 1 and its monthly variations are presented in Fig. Minimum DO of 4 mg/l is essential to sustain the aquatic ecosystem. Organic wastes discharged into the river would deplete the DO and the depletion depends on the initial DO, river flow and the quantity of waste discharged in terms of BOD. However, it is to be noted that DO is replenished into the river system by several mechanisms like aeration and algal photosynthesis mainly. The DO levels in the lakes which serve as drinking water sources for Hyderabad are reasonably good except in the Month of August where there was peak rainfall. This can be attributed to the first flush effect that results in depletion of DO. In the locations namely, Nagole and Peerjadiguda the DO concentrations indicate heavy pollution especially in the dry season where river flow is very low. Also, in the downstream location the water quality is poor indicating decrease in fish and macro invertebrate populations. As the river receives lot of wastewater inflows from the city, the water quality of the river except for the upstream locations in terms of DO is to be rated as poor.

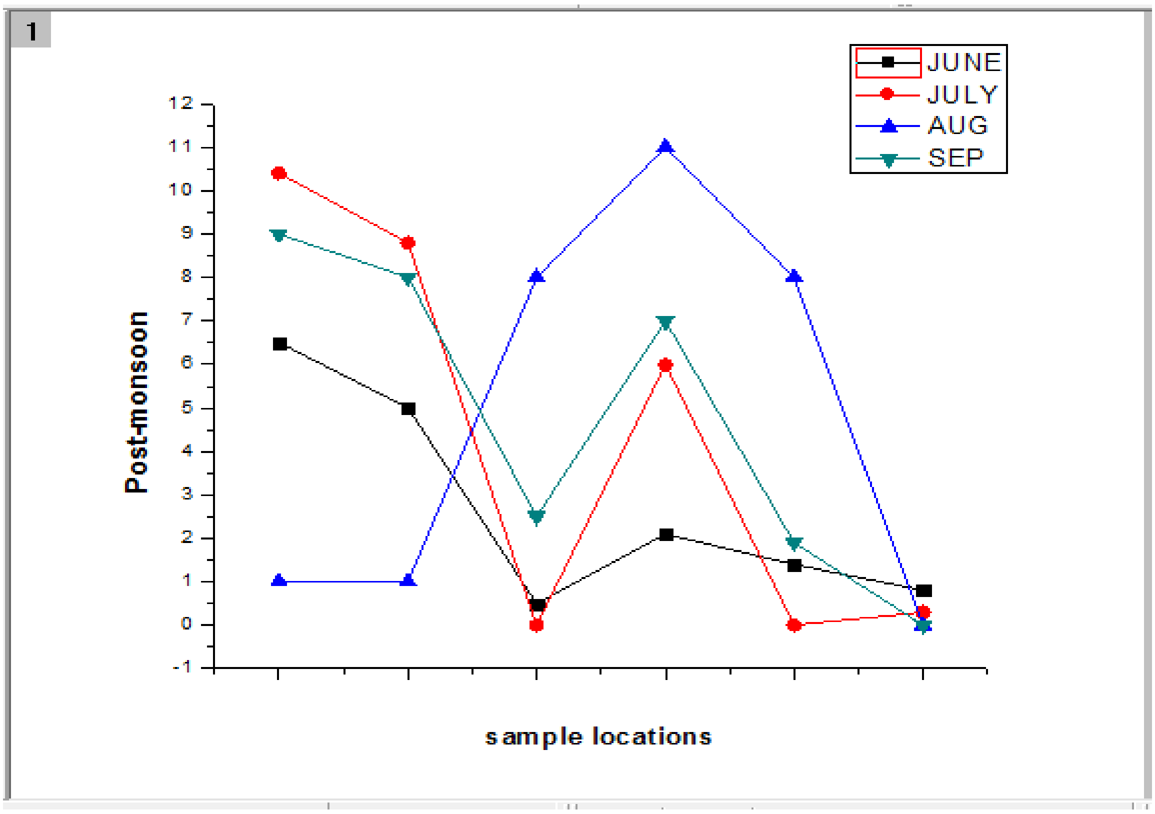
Table: 5.1 DO Levels at various locations on River Musi

Sampling Location	Pre-monsoon				Monsoon			
	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP

Osmansager lake (upstream)	8.7	6.5	6.2	8.3	6.5	10.4	1	9
Himayath Sager lake (upstream)	7	5.7	0.2	6.9	5	8.8	1	8
Nagole (middle stream)	0	0	0	0	0.5	0	8	2.5
Peerjadiguda (middle stream)	0	0	0	0	2.1	6	11	7
Pratap singaram (down stream)	0.8	0.3	0	0	1.4	0	8	1.9



Graph: 5.1 DO at Various locations on River Musi Pre-monsoon

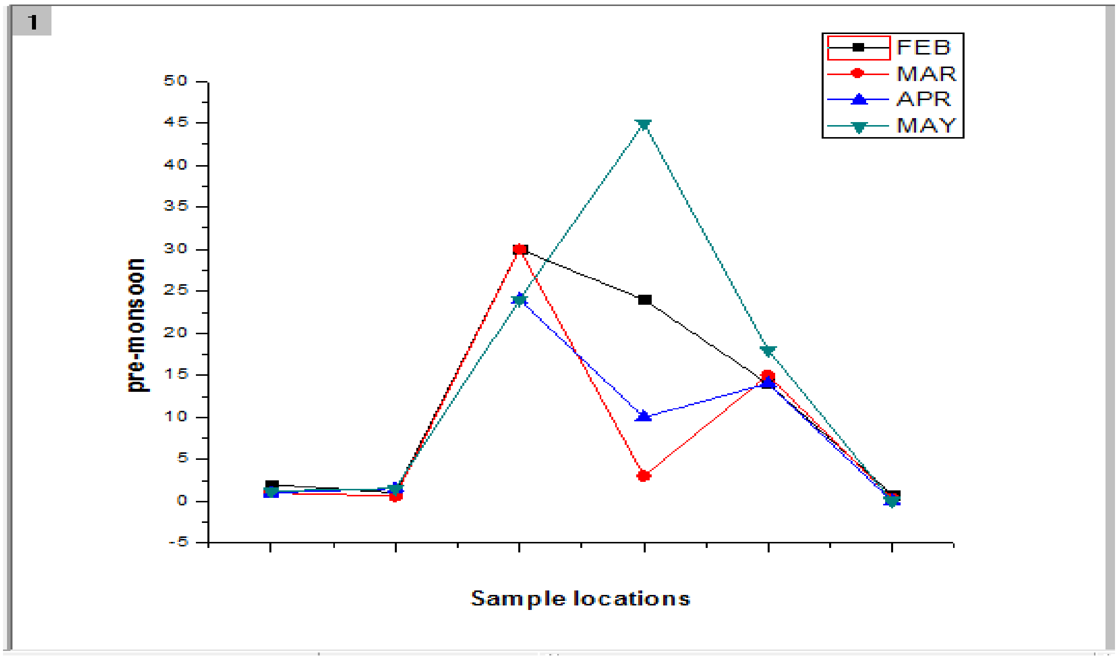


Graph:5.2 DO at Various locations on River Musi Post-monsoon

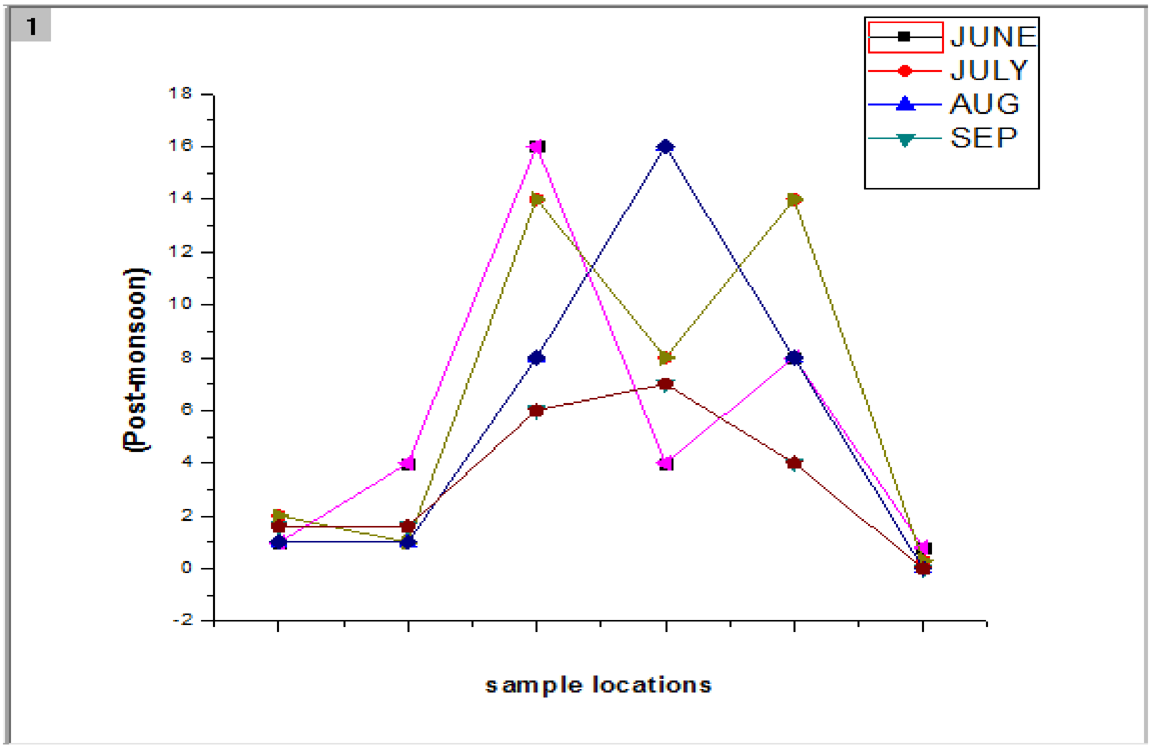
The BOD concentrations as obtained from different locations of the River Musi are presented in The monthly variations in BOD are shown in The upstream sampling locations on the river namely, Osmansagar lake and Himayath sagar lake reported low levels of BOD ranging between 1 to 2. As indicated by DO levels the water quality at these two locations is very good and hence, the fact supports use of water from these locations for drinking water supply. The locations Nagole and Peerjaguda highest recorded BOD was 30 mg/l, as they receive wastewater inflows from the urban area. The effluent standards for discharge of wastewaters in terms of BOD is 30/ mg/ l, the BOD for most part at these locations is similar to that of treated wastewater, which is not an encouraging observation for water quality. The BOD levels are less in the monsoon season indicating dilution effect. The BOD levels during the dry season are higher as the river flow is nominal and the contribution from wastewater would be significant.

Table. 5.2 Biological Oxygen Demand at various locations on River Musi

Sampling Location	Pre-monsoon				Post Monsoon			
	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
Osmansager lake (upstream)	2	1	1	1.2	1	2	1	1.6
Himayathsager lake (upstream)	1	0.6	1.5	1.5	4	1	1	1.6
Nagole (middle stream)	30	30	24	24	16	14	8	6
Peerjadiguda (middle stream)	24	3	10	45	4	8	16	7
Pratap singaram(down stream)	14	15	14	18	8	14	8	4



Graph: 5.3 Biological Oxygen Demand at various locations on River Musi Pre-monsoon

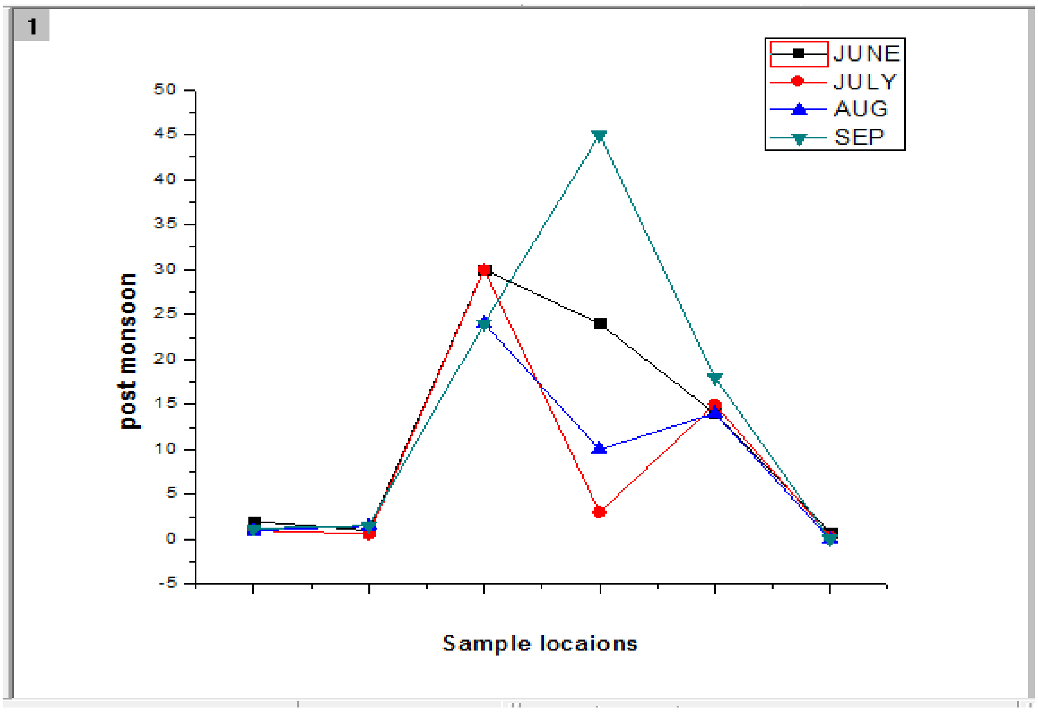


Graph:5.4 Biological Oxygen Demand at various locations on River Musi Post-monsoon

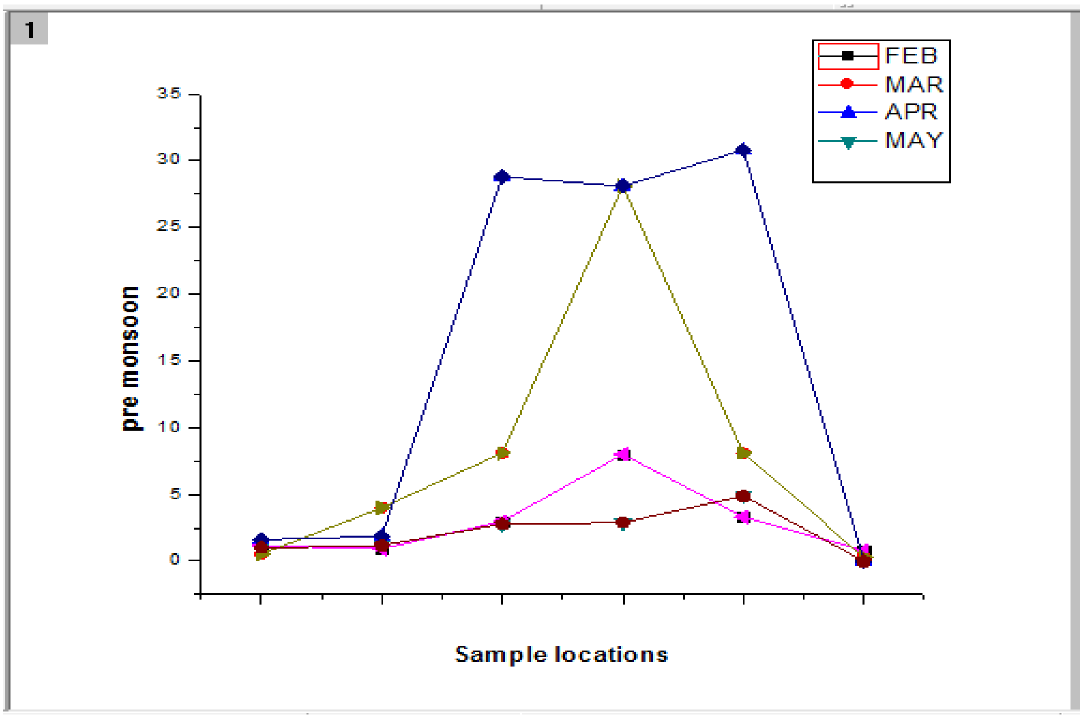
BOD values indicate the pollution status of the river and the water quality at the upstream locations on the river Musi indicates good status. The same is in compliance with the observations with DO values. Generally, DO, BOD and COD are used as pollution indicators and assess the water quality status of the system under question. The BOD values of the upstream locations are low indicating good water quality compared to that of the other three locations which receive considerable pollution from wastewater discharges. Seasonal variations are supported by the variations in rainfall.

Table: 5.3 Nitrate Concentrations at various locations on River Musi

Sampling Locations	Pre-monsoon				Post Monsoon			
	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
Osmansager lake (upstream)	1.17	0.53	1.62	0.99	5.31	1.80	12.80	3.00
Himayathsager lake (upstream)	0.93	4.00	1.87	1.19	4.85	1.40	0.37	3.00
Nagole (middlestream)	2.98	8.10	28.80	2.78	8.02	23.00	15.50	4.00
Peerjadiguda (middlestream)	8.00	28.10	28.10	2.89	12.00	10.00	7.40	8.00
Pratapsingaram (downstream)	3.32	8.10	30.80	4.89	7.88	12.70	13.90	12.00



Graph: 5.5 Nitrate Concentrations at various locations on River Musi Pre-monsoon



Graph: 5.6 Nitrate Concentrations at various locations on River Musi Post-monsoon

The Musi River has been reduced to a sewer drain carrying the domestic and industrial waste generated in Hyderabad city especially in the premonsoon season in the downstream stretch. About 15 MLD (million liters/ day) of industrial effluents containing mainly nitrates, phenols and cyanides from about 100 units under hazardous category in the Jeedimetla industrial estate, in addition to 55 MLD (million liters/ day) domestic sewage, are released into

Kukatpally Nallah which flow into Hussain Sagar lake in the centre of the city. Hussain Sagar water along with wastewater in flows join to Musi River.

Forage Grass

Table 5.4 presents concentrations of metals in forage grass samples along with the normal range of metal accumulation in plants and control values. These data are further assessed by calculating the plant-to-soil ratios commonly known as transfer coefficients, a convenient way of quantifying relative differences in bioavailability of metal and considered that plant/soil ratios for any particular element of 0.1 indicate that the plant is excluding the element in its tissues. Although soil concentrations may be high and source metals may be taken up in the roots, only a portion of the root uptake is Trans located to the leaves, giving a leaf/soil concentration ratio of about 0.2. Based on this, we suggest that transfer factors above 0.2 indicate anthropogenic contamination of the plants. Gave a generalized transfer coefficient for soils and plants based on the root uptake of metals. However, soil pH, soil organic matter, CEC, and plant genotype pecan markedly affect metal uptake. The generalized coefficients were in concurrence with the studies of Forago and Thornton (1997) except for Cd and Zn, which had maximum transfer factors of 10.

Table 5.4 Metal concentration in fodder grass (μg/g) and plant soil transfer coefficient values

Metal	Normal ranges	General transfer values	Control values	Musi fodder grass values	Transfer coefficient values from Musi river plant
Zn	1–100	1–10	2.4–8.2	164.2–212.4	0.53–0.68
Cr	0.03–14	0.01–0.1	0.06–0.91	20.2–36.7	0.70–0.95
Cu	5–20	0.01–0.1	0.02–0.26	15.7–29.6	0.76–0.84
Ni	0.02–5	0.01–1.0	0.23–1.6	10.7–18.3	0.29–0.38

This is due to high mobility and phyto availability of these two metals, which is a reflection of their relatively poor sorption in soils. In contrast, metals such as Ni, Co, and Pb have low transfer coefficients because they are strongly bound, usually to the soil colloids. The results of our study were in good agreement with the earlier two hypotheses and that of our fractionation studies of soils, which clearly indicates high concentration of Zn, Cu, and Cr in plants and high transfer coefficient values compared to Ni, Co, and Pb. Table also contains the metal concentrations in control samples, which is generally free from anthropogenic contamination. Among As, Cd, and Hg, the highest transfer factor was recorded for Cd, a reflection of its relatively high mobility and phyto availability in soil.

Milk: Concentrations of metals in milk are presented in Table 3, which clearly indicates high concentrations of all six metals and of Zn, Cu, Cr in particular. The concentration of cadmium ranged between 0.02–0.04 µg/mL in milk samples, a consequence of the values in the forage grass. Concentrations of metals were high in buffalo milk compared to cow milk and this can be attributed to the high fat content in buffalo's milk (Indian Diary 2004), which helps in metal retention due to the formation of bioactive (lipophilic) complexes. These concentrations of metals in milk are clear reflections of the fractionation data and respective concentrations in forage grass. Repeatedly feeding this forage grass as fodder to cattle may result in the exposure of humans through thefood chain.

Table 5.5 Concentration of metals in milk (µg/mL) from the study area

Metal	Control	Cow's milk	Buffalo milk
Zn	0.06–1.0	1.9–4.3	2.7–6.3
Cr	0.06–0.08	1.2–2.7	1.6–3.9
Cu	0.03–0.06	0.96–2.2	1.1–2.4
Ni	0.02–0.05	0.69–2.0	0.8–1.9

6.0 Conclusions

Domestic and industrial activities are the main point source contributors in the basin. The sources of pollutants themselves variable according to diverse antecedent conditions, seasonal variations and large scale climatological and meteorological conditions covering the river basin. These are differentially activated according to rainfall structure and distribution over space and time. The intensity, frequency and amount of rainfall determine the dilution and first flush processes within the river. The mobility of pollutants depends heavily on treatment facilities and their efficiency. Different sources present changing profiles, however the present study reports only the basic water quality status of the river. Source inventory in the river basin is essential for comprehensive classification and for identification of changing trends in each pollutant and the source category. The concentrations of metals were found to be high and in agreement with topography and slope, which resulted in higher concentrations of metals on the left side of the Musi River and due to reduced thickness of fractured and weathered zones, the left bank is more susceptible to metals contamination. From these studies we infer that pollutants entering the surface on either side of the Musi will migrate toward the river and ultimately travel downstream to the north east.

7.0 References

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