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Assessment of Heavy Metal distribution of Water and Sediments in Kolleru Lake A.P

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Abstract: *To identify the metal concentration levels of Zinc, Cadmium, Lead, Chromium, Copper, Nickel and Iron were studied in water and sediments of Kolleru Lake A.P, India. Water and sediment samples were collected monthly from the study area during October 2015 to September 2016.The samples were collected from 8 sampling stations of Kolleru Lake. Sampling stations were selected based on inlet of lake, lake points and outlet of the lake. From each sampling station water and sediment samples were collected and analyzed by using AAS. Microwave digestions have been used for sample preparation method. Metal analysis in water and sediments were calculated by using AAS & ICP-OES Spectrometers. The paper discusses the analysis heavy metals of in water and sediments of 8 locations in Kolleru Lake. Result shows that high concentrations of metals, Lead, Chromium, Copper, Nickel, Iron in sediments comparatively than in water.*

Keywords: *Kolleru Lake, Metal analysis, Physico-chemical parameters, Sampling stations, Sediments, Water.*

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I. Introduction

Fresh water ecosystems including rivers and lakes are affected by pollutants and metal contaminants through manmade activities. Several studies reported that metal accumulation in water and sediments are in undesirable limits and deteriorate the quality of water and affect the biology of lake. Kolleru Lake is the largest fresh water lake in India and supporting rich biodiversity including aquatic vegetation, fishes and birds including Grey pelicans. Agricultural runoff, aquaculture effluents reaches the lake through drains and streams and changes the quality of lake and in turn affects the biodiversity of lake. The present study is aimed to study the ecological status of heavy metals in Kolleru Lake with the following objectives. To investigate the analysis of heavy metal concentration levels in water and sediments. To evaluate the reasons of heavy metals present in water and sediments of Kolleru Lake and to develop baseline data of Heavy metals. Monthly, seasonal variations and year wise variations of Zn, Cd, Pb, Cr, Cu , Ni , Fe and asses the level of concentrations.

Presence of heavy metals in water and sediments from different places of Kolleru Lake indicate that the lake is facing heavy metal pollution. Contamination of fresh water lakes by metal accumulation has become a major problem in developing countries. Recent research findings show that the Kolleru Lake was greatly affected by discharges released from aquaculture fish tanks and agricultural fields. Chandrasekhar et al., [1], (2003) studied the revealing differences in the accumulation pattern of heavy metals in fish inhabiting sediments characterized by varying metal bioavailability. Their studies clearly indicate that the fish of Kolleru Lake are contaminated with metals and not advisable for human consumption. Trace metal contaminants in aquatic ecosystems pose a serious environmental hazard because of their persistence and toxicity. The distribution of trace metals (Pb, Cd, Cr, Mn, and Cu) in water, sediment, by using Atomic absorption spectroscopy was studied by S.Adhikari et.al.,[2],(2009).Shibani Rosyshree Mishra et al., [3], (2010), investigate the impacts of aquaculture -led encroachment, which has to be detrimental to the ecological health of environments in the Chilika Lake. The result of encroachment has been increased biotic pressure on the lakes environment. Studies on Geochemical behaviour and distribution of heavy metals in sediments of Tirumalairajan river estuary,South coast of India ,suggested that the sampling site had not been polluted by heavy metals and they are present in limits.Senapathi Venkatramanan et al.,[4],(2015).

II. Study Area

Kolleru lake is the largest natural fresh water lake in India. The Ramsar Convention (IUCN, 1971) was the first to identify the lake in coastal Andhra Pradesh as a wetland. It is located between two major deltas, Godavari on the east and Krishna on the west. It is situated partly in Krishna and partly in West Godavari districts. The lake (Long 81^0 - 40' to 80^0 – 20' East, Lat 17^0 – 25' to 16^0 – 28' north) has an area of 954 Sq. Kms. At 3 MSL to + 10 MSL. The lake receives water from the catchment area extending over an area of 3,405

sq. km of upland and 1360 Sq. km of delta totalling 4,765 sq. km. A number of streams open into it. They include Tammileru, Budameru, Ramileru, Gunderu. The only outlet is Upputeru which connects the lake to Bay of Bengal.

III. Materials And Metals

The present study carried out at 8 sampling stations in Kolleru Lake. Sampling stations were selected based on inlet of lake, lake points and outlet of the lake having ecological significance. Sampling stations are Atapaka, Pedayadlagadi, Kolletikota, Singaralathota, Gudivakalanka, Upputeru –Panchekalamarru, Upputeru – Kottada, Mondukodu drain**.**

Sediment sampling

Sediment samples were collected monthly (October 2015-september 2016) from 8 sampling stations. Sediment samples were collected by Grab sampler, and transferred to clean polythene bags. On the same day the samples were carried to labs and analyzed. First samples are undergo the process of microwave digestion .Under 100^0 c samples were dried and grinded with mortar and pistil and sieved. Further sample processed (plate equal distribution) and spread in 8 parts. Finally randomly selected and prepared the sample.
1gm sample mixed with 5ml Hno_3 and 2 ml Hcl placed in microwave digestion system and filtered. The filtrate makeup to 100ml with distilled water.

Water sampling

Water samples were collected monthly from 8 sampling stations of Kolleru Lake during Oct 2015 to Sep 2016.Samples were collected in one liter bottles and preserved with the addition of few drops of Conc Hno_3 and immediately carried to lab and analyzed. All the water samples were acidified at the time of collection with nitric acid. At the time of analysis the sample is heated with acid and substantially reduced in volume. The digestate is filtered and diluted to volume, and is then ready for analysis. Physico-chemical analysis was carried out for water and sediment samples in sampling sites of Kollru Lake. PH was recorded with a portable meter Horiba U-51, Japan. Sample preparation and chemical analysis procedures were performed according Andrew D.Eaton et al., [5],19^{th} Edition 1995 and values measured by AAS &ICP-OES spectrometers.

IV. Results And Discussion

Present study carried out to estimate the concentration of metals in the 8 sampling stations of kolleru. The concentrations of seven heavy metals Zinc(Zn) ,Cadmium(Cd), Lead(Pb), Chromium(Cr), Copper(Cu), Nickel(Ni), Iron(Fe) were analyzed in water and sediments of all the sampling stations. From the data of monthly variations, season wise and tear wise average was calculated for all the metals in sediments and water. Eight different sampling stations were selected for the present study. The 8 sampling stations are, Atapaka, Pedayadlagadi, Kolletikota, Singaralathota, Gudivakalanka, Upputeru –Panchekalamarru, Upputeru – Kottada, Mondukodu drain. Sampling station 1 **Atapaka** is a bird habitat and meant for resident to migratory birds, station 2.**Pedayadlagadi** is a lake view point with broad area ,station 3 **Kolletikota** is a place of lake point and it is considered as heart of kolleru because water present throughout the year and with its natural eco environment , 4 **Singaralathota** is a place where pisciculture excessively carried and meant for only aquaculture without vegetation, 5th field station is **Gudivakalanka** a vast area of lake and surrounded by many fish ponds,6 **Upputeru -Panchekalamarru** is a place which connects Upputeru it is,7 **Upputeru-Kottada** is a large outlet where ,morning fresh water flows from kolleru to Upputeru ,evening salt water flows from sea to kolleru through outlet . 8th station is **Mondukodu drain** which is inlet of lake and carries water from inflowing drains and channels Results indicate that uneven distribution of metals among field stations, even same metal shows different concentrations among the field stations. Zn, Cd, Pb,Cu, and Ni are detected in water of all sampling stations. Chromium and Iron were not reported in all the eight sampling stations. Of all the seven metals except Cadmium remaining Zn,Pb,Cr,Cu,Ni,Fe were reported in sediments of all the sampling sites in high concentrations.

Zinc

Zinc concentration in water samples was in the range 0.03mg/l to 0.06 mg/l. The maximum concentration of Zinc in water was observed in Singaralathota , lower concentration of Zinc was observed in Gudivakalanka . High levels of Zinc in Singaralathota may be due restricted mobility of water because of aquaculture operations and fish bunds. Low concentration of Zinc in Gudivakalanka may be due to its large area with natural vegetation and the same being monitored by Kolleru bird sanctuary board. High concentration of Zinc in Pedayadlagadi sediment was recorded due to low level of water throughout the year. Low concentration of Zinc was reported in Upputeru -Kottada as it is the outlet of the lake which also carries away the same.

Table: 1 Zinc Concentration Levels Among Field Stations In Water And Sediments

Sampling Stations	Zinc Concentration Level	
	Water mg/l	Sediments mg/kg
Aatapaka	0.055	87.125
Pedayadlagadi	0.05	88.75
Kolletikota	0.042	61.14
Singaralathota	0.061	73.07
Gudivaka lanka	0.037	75.93
Upputeru-Panchekalamarru	0.049	72.85
Upputeru- Kottada	0.056	26.17
Mondikodu Drain	0.050	71.43

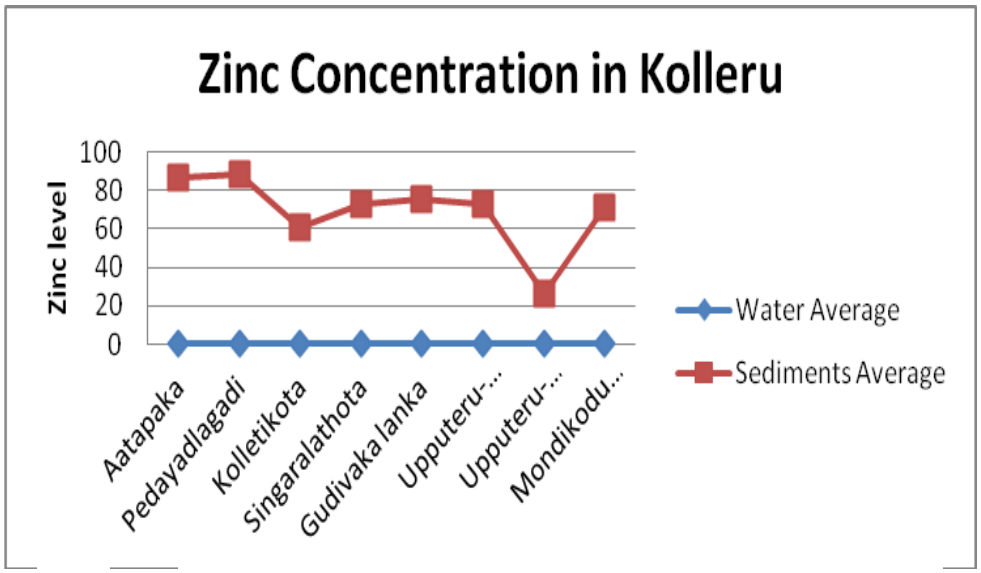


Fig: 1 Zinc Concentration levels among field stations in water and sediments

Cadmium

Cadmium was reported only in water samples of all sampling stations. High concentration of Cadmium in Pedayadlagadi & Upputeru -Panchekalamarru indicated the presence of waste discharges from nearby municipalities -Eluru,Vijayawada , Kaikaluru, surface runoff from agricultural fertilizers , aquaculture ponds, and particulate matter deposition etc. High level of Cadmium in aquatic ecosystems shows great threat to aquatic life. Low level of Cadmium in Gudivakalanka suggested low anthropogenic input.

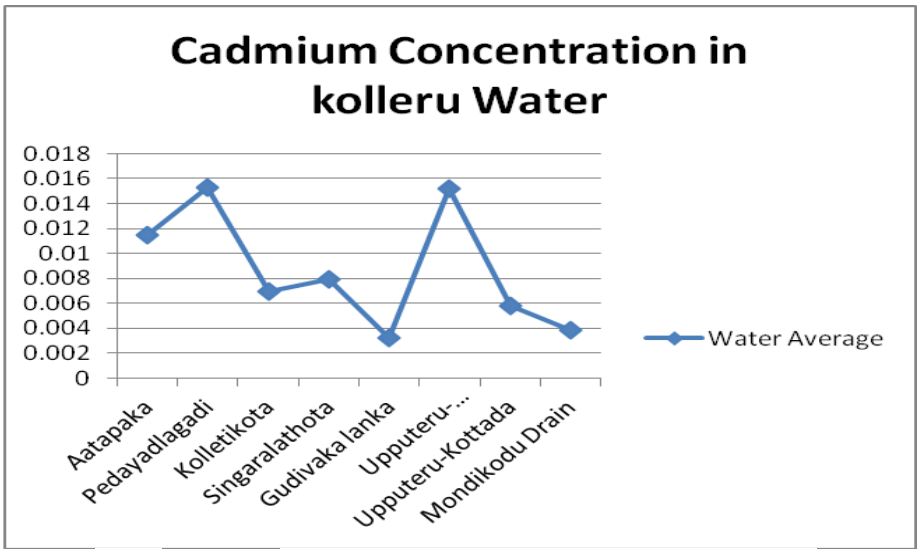


Fig: 2 Cadmium Concentration levels among field stations in water

Lead

Concentration of Lead in water of all the sampling stations ranged between 0.06 mg/l to 0.14 mg/l. In all the collected water samples, concentration of Lead was reported above the permissible limit by WHO (0.05 mg/l). High concentration of Lead in 1st sampling station Atapaka was 0.14mg/l. It may be due to phosphate rich faecal matter from birds because Atapaka is the best place for birds in Kolleru and provide typical habitat for many migratory and resident birds. Another reason is mixing of agricultural runoff from agricultural fields. But Lead concentration in Atapaka sediment recorded low concentration (against higher concentration of Lead in water) as it is connected to the lake only on one side and due to continuous monitoring of kolleruboard. High concentration of Lead in Gudivakalanka was due to agricultural runoff from agricultural fields. Low concentration in Upputeru – Panchekalamarru as it is the outlet of the lake.

Table: 2 Lead Concentration Levels Among Field Stations In Water And Sediments

Lead Concentration in kolleru				
Sampling Stations	**Water**	**mg/l**	**Sediments**	**mg/kg**
Aatapaka		**0.141**		**0.275**
Pedayadlagadi		**0.113**		**1.15**
Kolletikota		**0.114**		**0.425**
Singaralathota		**0.086**		**0.591**
Gudivaka lanka		**0.090**		**4.283**
Upputeru-Panchekalamarru		**0.086**		**0.275**
Upputeru-Kottada		**0.097**		**1.2**
Mondikodu Drain		**0.066**		**3.666**

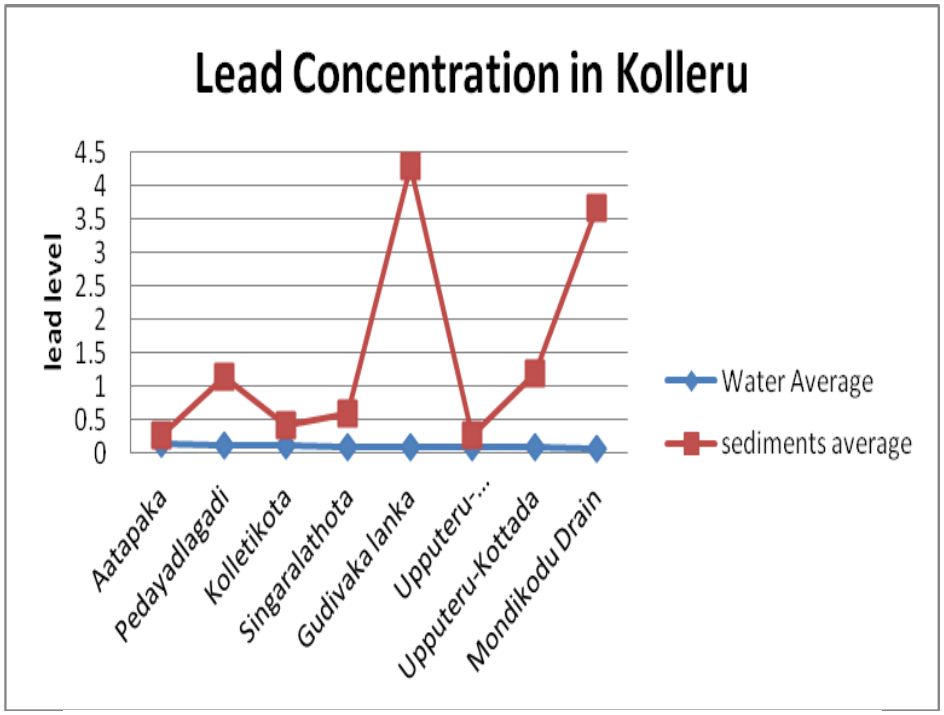


Fig 3 Lead Concentration levels among field stations in water and sediments

Chromium

Chromium was not observed in all the water samples. But higher concentration of Chromium was recorded in all sediment sampling sites indicating that the sites are highly polluted areas. The sampling site of Gudivakalanka showed higher concentration when compared to other sites. High amounts of Chromium in all the sampling sites except in Upputeru -Kottada due to dumping of dead organisms, aquaculture input, low level of water, faecal matter of birds. Low concentration of Cr in Upputeru-Kottada was due to its long outlet which is far away from the inlet.

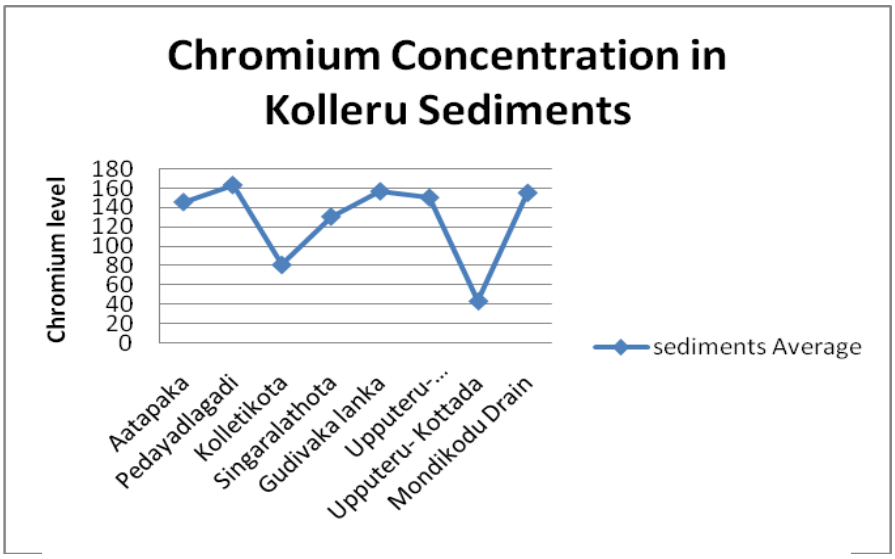


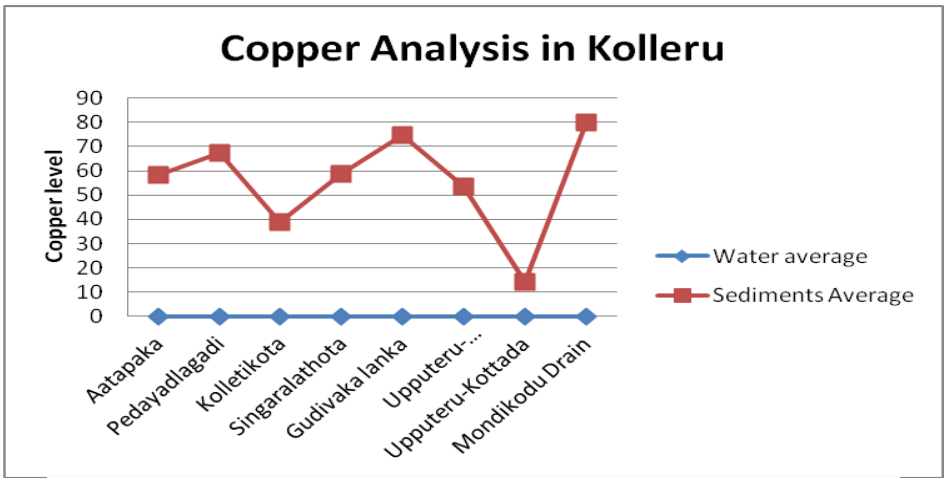
Figure 4 Chromium Concentration levels among field stations in sediments

Copper

High concentration of Copper was recorded in all the water and sediment samples of the lake. Fig ;5 Shows that high amount of Copper in the water samples of Pedayadlagadi & Gudivakalanka , the reason being low PH (6,26 & 6.60) of water and mixing of aquatic feed in water from ponds. Concentration of Copper in all the sediment samples was above the maximum permissible limit by WHO. Concentration of Copper in sediment samples ranged between 14.03 mg/ kg to 79.93 mg/kg. High amount of Copper in Mondukodu drain is because of the addition of high levels of aquatic feed, agricultural input, industrial wastes,and the drain being the main inlet of the lake. From the above analysis Mondukodu drain & Gudivakalanka are considered to be the highest polluted sites.

Table: 3 Copper Concentration Levels Among Field Stations In Water And Sediments

Copper Concentration in Kolleru		
Sampling Stations	**Water mg/l**	**Sediments mg/kg**
Aatapaka	**0.002**	**58.083**
Pedayadlagadi	**0.004**	**67.55**
Kolletikota	**0.002**	**38.925**
Singaralathota	**0.003**	**58.833**
Gudivaka lanka	**0.004**	**74.625**
Upputeru-Panchekalamarru	**0.003**	**53.35**
Upputeru-Kottada	**0.004**	**14.033**
Mondikodu Drain	**0.003**	**79.933**



Fig; 5 Copper Concentration levels among field stations in water and sediments

Nickel

Nickel was observed in water and sediments of all sampling sites. Maximum concentration of Nickel in Pedayadlagadi water was due to discharges from drainage pipes, agricultural tubes and pumps and aquacultural metal implements. Low concentration of Nickel in Atapaka was due to monitoring of water by kolleru board as this place is habitat for many migratory and resident birds. High concentration of Nickel in sediment of Gudivakalanka was noticed as it is one of the agricultural & aquacultural based areas. In addition to it is also polluted by the inflow from various channels. As Atapaka is the protected area by the board, disposal of wastes is minimized, so low concentration of Ni was observed.

Table: 4 Nickel Concentration Levels Among Field Stations In Water And Sediments

Nickel Concentration in kolleru		
Sampling Stations	**Water mg/l**	**Sediments mg/kg**
Aatapaka	**0.001**	**78.891**
Pedayadlagadi	**0.023**	**107.25**
Kolletikota	**0.022**	**49.041**
Singaralathota	**0.021**	**82.7**
Gudivaka lanka	**0.023**	**128.15**
Upputeru-Panchekalamarru	**0.023**	**92.133**
Upputeru-Kottada	**0.023**	**5.15**
Mondikodu Drain	**0.021**	**135.2**

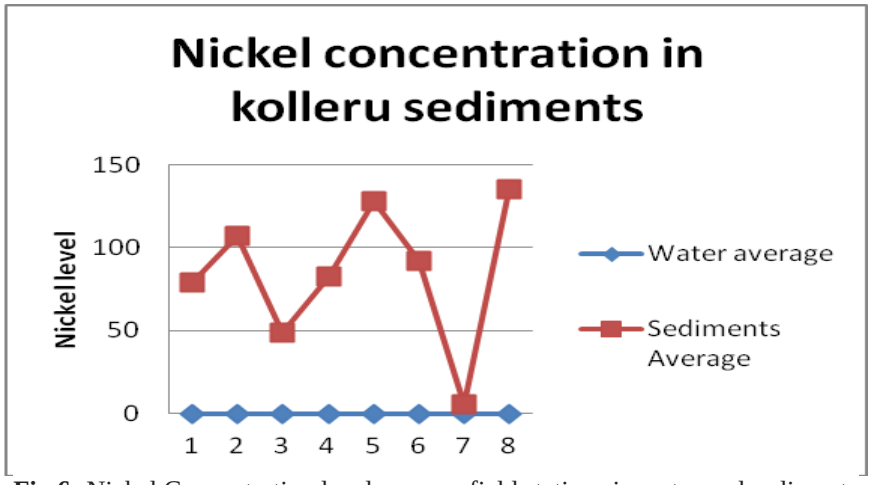


Fig 6: Nickel Concentration levels among field stations in water and sediments

Iron

Iron was not found in water of all sampling sites. But in all sediment samples high concentration of Iron ranged 2254mg/kg to 7729mg/kg. Iron is one of the ingredients of fish & prawn-feed (domestic discharge) and feed was excessively used by aquacultural field & it is discharged into lake through various channels. The excessive feed reaches to kolleru from aquacultural ponds and finally settled on sediments. In all the sediment samples concentration of Iron was above the permissible limit (313mg/kg).

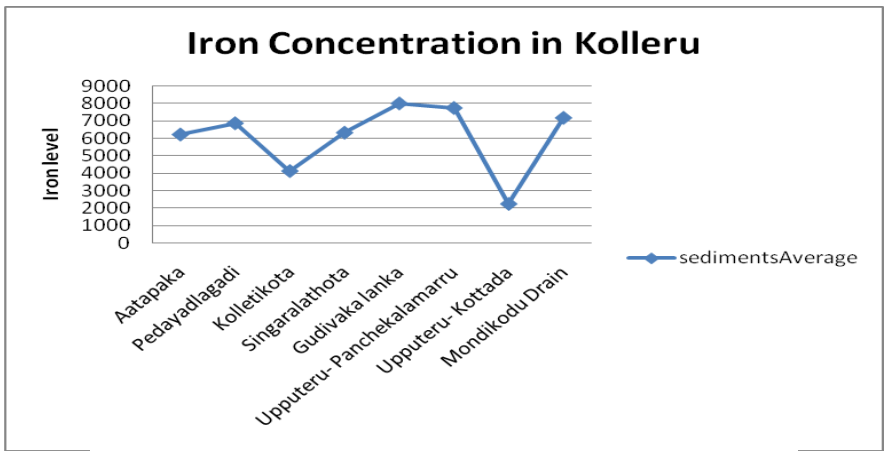


Fig 7: Iron Concentration levels among field stations in sediments

V. Conclusion

Based on the above results, the water and sediments in 8 field stations of Kolleru Lake were polluted with the contamination of heavy metals in large concentrations due to aquaculture, agriculture and anthropogenic activities. The concentration of Iron, Chromium, Zinc, Copper, and Nickel is high in sediment samples of Kolleru. Stagnation of water and deposition of sediment is the main cause. Even though concentrations of Zinc, Lead, Copper, and Nickel were low in water compared to sediments, they caused the deterioration of water quality.

The presence of high concentration of heavy metals in sediments and water in Kolleru Lake might affect aquatic life and there may be a threat of turning fresh water lake into brackish water lake. So continuous monitoring has to be carried out on the impact of aquaculture operations, anthropogenic input, and maintain the water flow rate at+5 Contour levels to protect the aquatic environment of fresh water lake.

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