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Studies on Heavy metal Contamination in Poovar Estuarine water, Kerala, South west coast of India

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Abstract : Analysis of heavy metal concentration in Poovar estuarine water was done for a period of one year from February 2016 to January 2017. The studies showed maximum concentration in the monsoon season for Iron, Manganese, Zinc, and Copper .The variation in the monsoon season may be due to huge surface runoff. Maximum concentration of Cadmium was observed in the post monsoon season and maximum concentration of lead was observed in the pre monsoon season. Minimum concentration of all the metals was observed in the pre monsoon season except lead. Lead concentration showed its minimum in the post monsoon season. The concentration of Iron, Lead and Copper exceeded the acceptable limits as per Beuro of Indian Standards. The value of Zinc was with in the acceptable limit. Cadmium showed slightly higher value from the acceptable limit in few stations during monsoon and post monsoon seasons . For manganese the value observed for pre monsoon season in station I only falls below than acceptable limit.
Key Words : Concentration, Season, Acceptable, environment.

Introduction

Heavy metals are intrinsic, natural constituents of our environment. They are generally present in small amounts in natural aquatic environments. Apart from the natural sources, several anthropogenic ones also contribute to metal concentration in the environment. Contamination of heavy metals in the aquatic environment has attracted global attention owing to its abundance, persistence and environmental toxicity[1]. Heavy metals are priority toxic pollutants that severely limits the beneficial use of water for domestic and industrial applications .Toxic elements can be very harmful even at low concentration if consumed over a long period of time. With increasing human population and rapid industrialization, the environmental pollution have become more and more critical. Both natural and anthropogenic activities are responsible for the abundance of heavy metals in the environment[2]. Trace metals pollution in aqueous system can hardly be eliminated and are often recycled via physiochemical and biological processes, which continue to pose a risk of adverse effects on human health and aqueous ecosystem . Mainly this heavy metal contamination occurs in the aquatic systems due to developmental activities, urbanization, and disposal of sewage from the agricultural fields that using more fertilizers .They become concentrated as a result of human caused activities and can enter plant, animal, and human tissues via inhalation, diet, and manual handling. Then, they can bind to and interfere with the functioning of vital cellular components. In humans, heavy metal poisoning is generally treated by the administration of chelating agents. Some elements otherwise regarded as toxic heavy metals are essential, in small quantities, for human health. The presence of pollutants in aqueous solution, particularly from hazardous heavy metals and metalloids, is an important environmental and social problem. As many of these elements are

stable they are bio-accumulative, and assessment of their safe limits is very difficult in the ecosystem. Toxicity of these elements is of considerable concern worldwide because of their environmental burden.

Experimental

Materials and Methods

The present study was carried out with special reference to Poovar estuary adjacent to the beach resorts of Poovar – Vizhinjam area in Thiruvananthpuram District, Kerala State. Poovar estuary is a bar built estuary of area 30.93 hectare and length 15 km and it is situated between 8°19'3"N to 77°4'7"E, and is formed by the confluence of river Neyyar.

The sampling stations in Poovar estuary are shown in Fig.1. Station 1 is Poovar estuarine mouth, station II is Mavilakadavu which is 5Km away from the estuarine mouth, station III is Kanjiramoodukadavu which is 8Km away from estuarine mouth, station IV is Parasserykadavu which is 11Km away from estuarine mouth, station V is Rameswaram temple bridge which is 14Km away from estuarine mouth.s

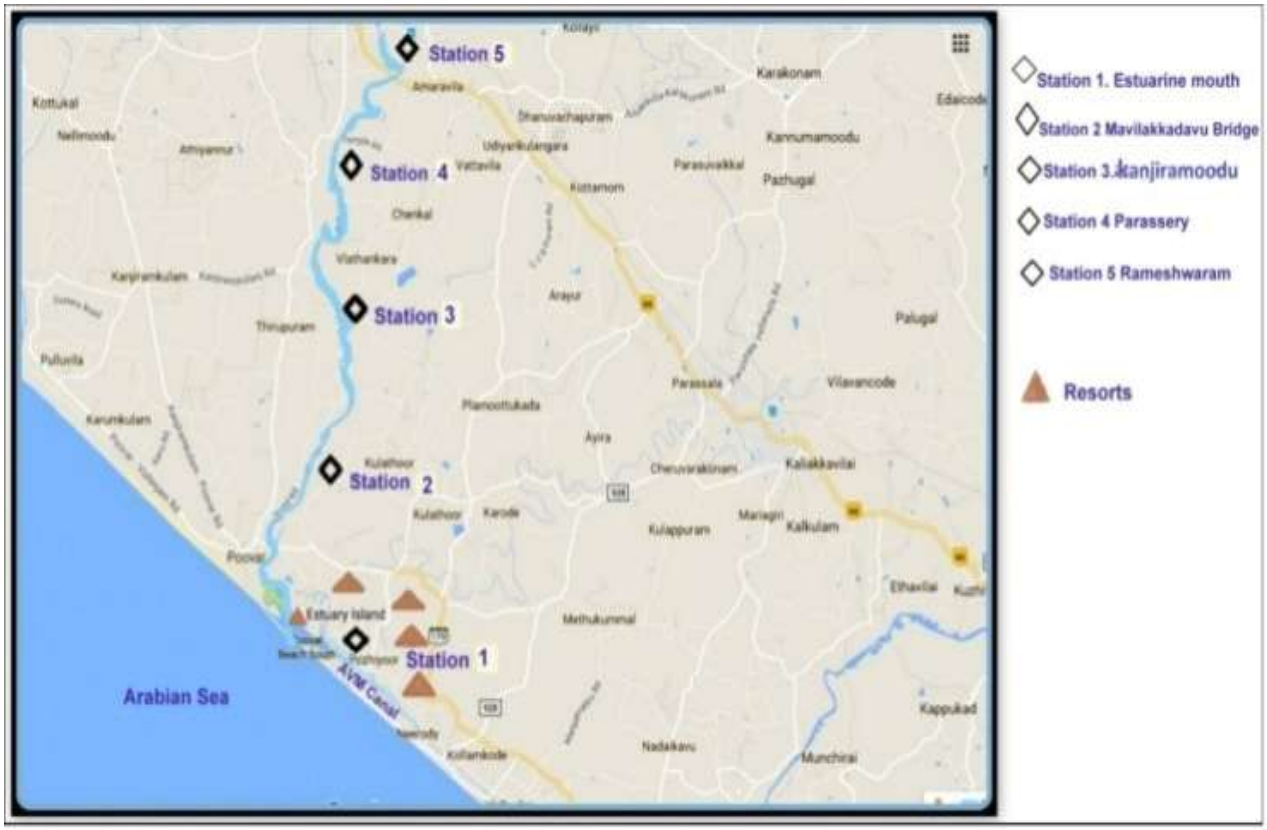

Fig 1: Location map of the study area showing sampling stations

Approximately two litres of water samples were collected from all the five stations during the period twelve months from Feb 2016 to Jan 2017 in clean plastic containers. One fraction of the sample was used for heavy metal analysis after treated with HNO_3. The heavy metals are analysed by using AAS Perkin Elmer (A Analyst 400)

The objective of the present study is to evaluate estuarine contamination by measuring richness of heavy metal accumulation.

Results and Discussion

The seasonal variation of heavy metal concentration of Poovar estuarine water is given in table 1 , 2 & 3.

Table 1 Heavy metal concentration in water during pre monsoon(ppm)

Station	Pre monsoon					
	Fe	**Mn**	**Zn**	**Cu**	**Pb**	**Cd**
I	1.38	0.06	0.05	0.18	0.42	BDL
II	1.75	0.16	0.17	0.32	0.56	BDL
III	1.94	0.21	0.19	0.36	0.60	BDL
IV	1.72	0.18	0.27	0.38	0.65	BDL
V	1.80	0.13	0.23	0.35	0.58	BDL
Mean	1.7195	0.148	0.179	0.315	0.561	BDL

Table 2 Heavy metal concentration in water during Monsoon (ppm)

Station	Monsoon					
	Fe	**Mn**	**Zn**	**Cu**	**Pb**	**Cd**
I	2.01	0.13	0.20	0.32	0.36	BDL
II	2.57	0.23	0.36	0.46	0.45	0.0058
III	2.74	0.32	0.38	0.48	0.46	BDL
IV	2.59	0.28	0.35	0.53	0.50	BDL
V	2.50	0.29	0.39	0.51	0.48	0.0070
Mean	2.4825	0.246	0.336	0.459	0.447	0.0024

Table 3 Heavy metal concentration in water during Post monsoon (ppm)

Station	Post monsoon					
	Fe	**Mn**	**Zn**	**Cu**	**Pb**	**Cd**
I	1.76	0.08	0.10	0.28	0.14	BDL
II	2.40	0.19	0.24	0.38	0.27	0.0125
III	2.52	0.23	0.31	0.44	0.25	0.0130
IV	2.24	0.22	0.29	0.43	0.28	0.0100
V	2.18	0.19	0.32	0.41	0.22	0.0250
Mean	2.2195	0.179	0.249	0.385	0.23	0.0121

The seasonal average concentration of iron varied from 1.38ppm to 2.74ppm. The maximum concentration was observed in station III during monsoon season and minimum was observed in station I during pre monsoon season. Iron may be released to water from natural deposits, industrial wastes, refining of iron ores, and corrosion of iron containing metals. The stabilisation by humic substances increases the bioavailability of iron and retard the oxidation of Fe (II)[3]. Iron exposure to high levels may disrupt the respiration process in fish with the physical clogging of gills[4]. The acceptable limit of iron as per BIS for drinking water is 0.3ppm. The concentration of iron exceeded the standard value in all the seasons.

Manganese is a vital micro nutrient for marine organisms and plays a significant role in photosynthesis[5]. It is also associated with some proteins and enzymes which regulate physiological functions. The seasonal average concentration of Manganese varied from 0.06ppm to 0.32ppm. The acceptable limit of manganese as per BIS is 0.1ppm. The maximum concentration was observed in station III during monsoon season and minimum was observed in the station I during pre monsoon season and the observed values were slightly higher than the accepeted values except station I . Important sources of manganese include soils, sediments, and metamorphic sedimentary rocks[6]. Manganese get accumulate in the glands and the blood of

animals and leads to different types of infections. Forest fires, vegetation, and volcanic activity are other major natural sources of manganese in the atmosphere [7]. Stokes estimated that two-third of manganese air emissions were from natural sources. The main anthropogenic sources of manganese release to air are combustion of fossil fuels, and entrainment of manganese containing soils[8,9]. Manganese can induce iron deficiency in some algae, notably blue-green algae, and this can lead to inhibition of chlorophyll synthesis .

The seasonal average concentration of Zinc in the water samples varied from 0.05ppm to 0.39ppm. The maximum concentration was observed in station V during monsoon and minimum was observed in station I during pre monsoon season. The acceptable limit of Zinc as per BIS is 5ppm and the values observed were below to the acceptable limit. Zinc is one of the important trace metal that plays a vital role in physiological and metabolic process in many organisms. Higher concentrations of Zinc is toxic to living organisms [10].The symptoms that an acute oral Zinc dose may include tachycardia, vascular shock, nausea, vomiting and damage of hepatic parenchyma [11]. Zinc is a micro nutrient for marine organisms, important in the enzymatic and metabolic regulation, but at high concentrations it becomes toxic and can cause different permanent and severe damages in the reproduction processes .Wind and water carry minute amounts of Zinc to lakes , rivers and the sea, where it collects as sediment or is transported further. Natural phenomena such as volcanic eruptions , forest fires, dust storms and sea spray also contribute to the continuous cycling of Zinc through nature.

The seasonal average concentration of copper varied from 0.18ppm to 0.53ppm. The maximum mean concentration was observed in station IV during monsoon and minimum was observed in station I during pre monsoon season.. The limit as per European standards in drinking water is 2mg/l and that by BIS is 0.05mg/l . The values observed in all the stations were with in the permissible limit as per European standards. But the values are higher than BIS for drinking water. Zinc and copper are generally good indicators of anthropogenic inputs[12].Copper at low concentration is essential for living organisms as it maintains cellular functions and it plays an important role as a co factor for different metabolic enzymes .It may become toxic to aquatic organisms when concentration exceed the recommended limits.The extensive use of antifouling paints would have released cuprous oxide which in turn enriches the copper content in water[13].

Shielding systems from radiation and X-rays, circuit boards in computers and electronics equipment's, superconductor and optical technology, insecticides, pigments, ceramics, enamels, glass, plastics and rubber products, wastes from runoff ,gasoline and house paint, which has been extended to lead bullets, plumbing pipes, storage batteries, toys and faucets [14], have contributed significantly for the wide distribution of lead in the environment .The main dissolved forms of Pb are $PbCO_3$ and PbOH . The average value of lead in three seasons varied from 0.14ppm to 0.65ppm and the maximum concentration was observed in station IV during pre monsoon season. The limit as per the European Union standards and BIS are 0.01ppm . The value of of lead exceeded the limit in all the stations in all the three seasons.

The presence of lead and cadmium in water are mainly by anthropogenic activities . The main source of cadmium is agricultural sludge .Cadmium can be taken up from different organisms living in the aquatic environment, stored in liver, kidney and gills, and cause problems in the enzymatic regulation of the carbohydrate metabolism. The maximum mean concentration of cadmium 0.025ppm was observed in the post monsoon season in station V. The limit as per the European Union Standards is 0.005ppm and as per BIS the acceptable limit is 0.003ppm for cadmium. The values observed in few stations were above to the acceptable limits during post monsoon and monsoon seasons. Cadmium disrupt the storage or mobilization of metabolic substrates like glucose, glycogen, lactate, lipids and proteins.

The distribution of heavy metals in water varied in the order of Fe>Pb>Cu>Zn>Mn>Cd for pre monsoon Fe>Cu>Pb>Zn>Mn>Cd for monsoon season and Fe>Cu>Zn>Pb>Mn>Cd for post monsoon season respectively. Highest values of Fe, Mn, Zn and Cu were observed in the monsoon season covering June , July, August and September of 2016 and minimum was observed in the pre monsoon season covering Feb, March, April and May of 2016. The maximum concentration of lead was observed in the pre monsoon season and minimum was observed in the post monsoon season. The maximum value of Cd was observed in the post monsoon season and minimum was observed in the pre monsoon season. The variation in monsoon may be attributed to huge run off from the adjacent land masses[15],and subsequent fresh water input bringing much land derived materials along with domestic and muncipal and agricultural wastes. The heavy metal components also were washed from the atmosphere through rainfall , wind, blown dust, forest fire and volcanic particles adding the distribution of heavy metals in water[16]. Several studies revealed that the presence of metallic ions in

solutions depends of pH and salinity. The lowering of pH might facilitate the dissolution of the precipitated form of metals and increase the amount of metallic ions in solutions. The lowest concentration of heavy metals in the pre monsoon may be due to usage of trace amount for the growth of phytoplanktons and also the inability of the metals to present in the water for long time. The highest value of lead during premonsoon season may be due to the over utilization of the stagnant water during pemonsoon season.

Conclusion

In the present study different heavy metal concentration in the water samples were analysed for a period of twelve months from Feb 2016 to Jan 2017. The concentration of the heavy metals were observed maximum in the monsoon season except cadmium and lead. The distribution of heavy metals in pre monsoon was in the order of Fe>Pb>Cu>Zn>Mn>Cd, the order in the monsoon season was Fe>Cu>Pb>Zn>Mn>Cd and that of post monsoon season was Fe>Cu>Zn>Pb>Mn>Cd. respectively. From the results it was observed that some stations in the study period were polluted by heavy metals. The heavy metal concentration of metals in water may cause reduction in water quality that will badly affect the aquatic organisms and will cause severe health problems to humans . So it is necessary to take measures to reduce water pollution by avoiding the direct discharges from agricultural lands and from all other sources.

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