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Contamination of trace metals (Zn and Cu) in the coastal water along Veraval coast, Gujarat (India)

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Abstract

The effect of trace metals (Zn and Cu) on coastal water of Veraval coast (Gujarat) India has been assessed in three locations along coast and compared with non-polluted area behind Jaleshwar temple, half km away from polluted area in Veraval coast as reference locality for one year during 2003 on monthly basis. The concentration of trace metals in coastal water were analyzed using stripping voltametry. The locations mean concentration of trace metals (Zn and Cu) in coastal water from polluted areas were 55.29 µg/l and 4.89 µg/l respectively. Where as, the mean concentration of trace metals (Zn and Cu) in coastal water at reference locality were 13.27 µg/l and 2.30 µg/l respectively. There was significant variation observed between polluted seawater and seawater at reference locality based on ANOVA. Present study showed that seawater near two industry and harbour was contaminated with trace metals than the reference locality. The present study is an attempt to assess the influence of anthropogenic activities in this area with specific reference to the concentration of trace metals.

Keywords : Trace metals, stripping voltammetry, coastal water

Introduction

Veraval is situated at latitude 20' 55' 62" N and longitude 70' 21' 37" E on the South West coast of Saurashtra peninsula facing Arabian Sea. The source of pollution along the coastal waters of Veraval are untreated sewage discharge from Veraval town, industrial waste from Indian Rayon Industry (Textile industry) through Devka river and agriculture waste from Hiran and Devka river. Discharges from fishing harbour, GIDC area and other fish processing plants/ cold storages/ice factories are also source of pollution to the coastal waters.

Disposal of sewage sludge can also contribute to metal enrichment (Cu, Pb, Zn, Cd and Ag) in receiving waters (1). Municipal waste water and the dumping of domestic and industrial sludge are the major artificial sources of Cd, Cr, Cu, Fe, Pb and Hg loading in the New York Bight (2).On the other hand, many trace elements are considered as essential for organisms and thus their relative abundance is influenced significantly by biological processes. In fact, it is well known that several trace metals such as Cd, Ni, Cu and Zn have a similar distribution pattern as algae micronutrients (3, 4, 5, 6, and 7). This is to be interpreted as these trace elements are involved in biological cycling, and thus its distribution and abundance can reflect biological activity (8). With the changing scenario of rapid industrialization of Saurashtra coastline, it is absolutely necessary to obtain a baseline data on the status of the coastal environment present today. This database will be a vital component to assess the impact of the industries and human pressure on the coastal environment in Veraval.

Material and methods

Samples were collected from three locations and reference site (Fig.1). Location-I is near mouth of Hiran River (HR) and adjoining sea. The sample of seawater was collected from meeting point of HR with seawater at the intertidal area (station-H2). One more sample was collected at 150 meter away inside the sea from discharge point (station-HS1). Location-II is near bar-mouth of harbour creek and adjoining sea. The samples were collected from meeting point of harbour water with open sea (station-C2) and 150 meter away inside the sea (station-CS1). Location-III is near mouth of Devka River (DR) and adjoining the sea. The sample of seawater was collected from meeting point of river with seawater at the intertidal area (station-D2). One more sample was collected at 150 meter away inside the sea from discharge point (station-DS1). Station near a relatively clean area behind Jaleshvar temple, 500 meter away from the discharge point of Indian Rayon Industry (Textile industry) effluent in Veraval coast was taken as reference site and sample was collected. Surface seawater sample were collected during high tide from the study area.

Seawater samples were filtered through a 0.45 mm cellulose acetate filter and organic matter was digested by adding HNO3 (Merck-Suprapur) to a final pH of <2 and kept in deep freezer for analysis of elements (Zn and Cu). Clean procedures were used in order to avoid contamination of water samples. Trace metals were analysed using Stripping Voltammetry in a 757 VA Computrace attached to 765 Dosimat (Metrohm, Switzerland), following the method outline by Anoop *et al.* (9). The accuracy of the analytical procedure was checked using certified reference material BCR - 403 (Community Bureau of Reference). The recovery was 99% for all metal studied, which was estimated by measuring standard spiked samples. All handling was processed in a clean room.

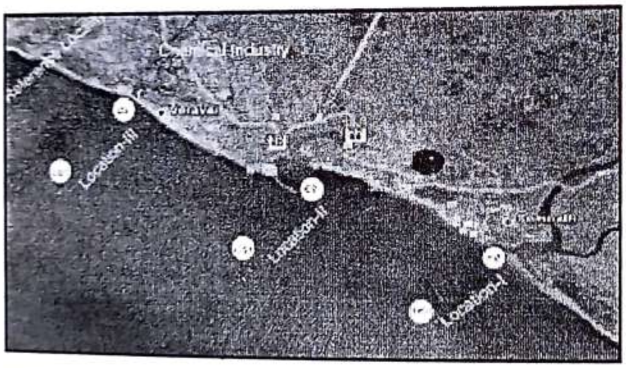


Fig.1. Map showing the sampling locations.

Result and discussion

Zinc (Zn)

Concentration of Zn at location-I ranged from 22.491 µg/l during month of September to 72.119µg/l during June at station-HS1, it ranged from 18.068 during December to 65.575 µg/l in July at station-H2. The annual mean concentration was 42.89 to 34.16 µg/l at station-HS1 and H2 respectively. The mean concentration of Zn was higher at HS1 and low value was observed at station-H2. The average concentration of Zn at location-I was 38.52 µg/l. Concentration of Zn at location-II varied from 21.766 during month of March to 54.214 µg/l in June at station-CS1. At station-C2 it ranged from 25.245 in November to 106.412 µg/l during July. The annual mean concentration was 39.496 at CS1 and it was 46.948 at station-C2. The average concentration of Zn at location-II was 43.22µg/l. The concentration of Zn was higher at station-C2 than CS1.Concentration of Zn at location-III varied from 13.289 during June to 153.731 µg/l during August at station-DS1, while it ranged from 23.505 during September to 236.852 µg/l in month of May at station-D2. The annual mean concentration of Zn was 60.367 and 107.899 µg/l at station-DS1 and D2 respectively. The average concentration of Zn at location-III was 84.133 µg/l. The value of Zn was more in open seawater than near discharge point at location-I, whereas at location-II and III it was higher in discharge point than the open seawater. The higher value in open sea may be attributed to mixing of domestic and chemical industry effluent at there locations. The average value of Zn in polluted sea water area was 55.29 µg/l, while in seawater of reference locality recorded 13.27 µg/l , it was found to be 24.0 % less at reference locality. ANOVA for Zinc did not show significant variation between stations in location-I and II with reference locality. It showed significant variation in station-D2 in location-III from all four stations of location-I, II and reference locality. There was no any significant variation was observed between stations in location-III (Fig. 2).

Copper (Cu)

The values of Cu at location-I ranged from Non-detectable range during March to 12.341µg/l in October at station HS1, while if ranged from Non detectable range during March, May, and August to 7.463 µg/l during December at station-H2. The annual mean concentration of Cu was 3.916 µg/l at station-HS1 and 3.696 µg/l at station H2. The average concentration of Cu in location-I was 3.806 µg/l. The concentration of Cu at location-II ranged form. Non detectable range during March, June, and October at station-CS1 to 8.887 µg/l during July in station-C2.The annual mean concentration of Cu was 3.846 and 0.786 µg/l at station-CS1 and C2 respectively. The average value of Cu at location-II was 2.316 µg/l. Cu concentration was signification higher in open seawater than the seawater at mixing point. The Cu content in location-III ranged from non detectable range during January, June, November, and December to 18.976 µg/e during July at station-DS1, while it ranged form non detectable range during January, February,

Table 1. Mean metal concentrations (mg/l) in seawater samples from the study area compared to the reference site

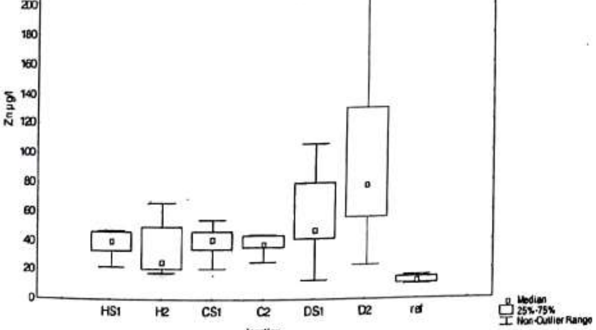
Metals	HS1	H2	CS1	C2	DS1	D2	Reference
Zn	42.89	34.163	39.496	46.948	60.367	107.899	13.270
Cu	3.916	3.696	3.846	0.786	4.233	12.905	2.300

April, June November and December to 99.496 µg/l during May at station-D2.The annual mean concentration of Cu at location-III ranged form 4.233 to 12.905 µg/l at station DS1 and D2 respectively. Average concentration was 8.569 µg/l at location-III. The value was more in seawater at mixing point than the open seawater. Among three locations, the average concentration of Cu was high at location-III followed by location-I and least value were in location-II. The high value at location-III can be attributed to discharge of Chemical industry effluent in this area. The average content of Cu in polluted seawater area was 4.897µgm/l, while in seawater at reference locality it was 2.30 µgm/l and 46.96 % less at reference locality. There was no significant difference between stations of polluted seawater and seawater at reference locality based on ANOVA (Fig.3).

Table 2. Metals concentration reduction in % between polluted and reference site.

Metals	Location mean of polluted seawater	Mean of reference site	% reduction
Zn	55.290	13.270	24.00
Cu	4.897	2.300	46.96

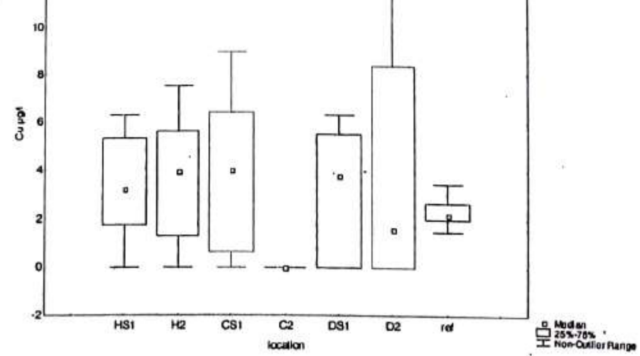
Fig.2. Mean Zn concentrations (mg/l) in sea water samples from different locations.



In the present study, metals like Zn and Cu were detected in seawater of Veraval. The observed value of Zn and Cu were found to vary from 55.29 and 4.89 µg/l respectively in polluted seawater. Keshav Rao and Indushekhar (10) reported Mn, Zn, Cu, Ni, and Co content in seawater of Div, Porbandar, and Okha on Saurashatra coast of Arabian Sea. The ranges of Mn, Zn, Cu, Ni and Co content are found to vary from 8.83 - 10.14, 10.54 - 11.89, 5.73 - 8.0, 2.63 - 3.05, and 0.78 - 0.83 µg/l in seawater. They have also suggested that these data in seawater may serve as baseline data for any further investigation on pollution aspect of coastal environment of Saurashatra. Tewari *et al* (11) has reported Cd, Zn, Pb, Cu, Mn, Fe and Ni in seawater of Macha near Porbandar (Porbandar seawater is polluted by discharge of chlor-alkali industry effluent). The ranges of Fe, Mn, Cu, Zn, Cd, Pb, Co, and Ni are vary from 42.21 - 54.58, 1.60 - 4.47, 2.28 - 5.48, 5.44 - 5.68, 2.9 - 3.08, 0.98 - 2.17, 0.982 - 1.29, 0.98 - 1.01 and 0.98 -1.22 µg/l respectively in seawater.

In the present study, the observed value of Zn is more than reported value in coastal water of Saurashtra. The value of Cu was comparable with reported value, while more or less similar value was observed at Mocha. The observed values of Cu in the present study were comparable with the data for the coastal waters of Arabian Sea of the West coast of India (12), but

Fig.3 Mean Cu concentrations (mg/l) in seawater samples from different locations.



less than that of Bombay Harbour Bay waters, (13). Zn content is more in the present study than the Bombay harbour bay and Arabian seawater. In the present study Zn and Cu content showed more value than the reported values in natural seawater (14). In the present study most of the metals showed low values in all near shore station and improve considerable in open water.

Nature and geographical location of Veraval in Arabian Sea is open marine area. The impact of semi-diurnal tide, high flow patterns give this area enough flushing twice a day and dilute and disperse the incoming polluted load. The domestic sewage, harbour water and industrial effluent though enter the coastal water at Veraval. The result do not revealed any significant impact on the water quality at Veraval coastal water with reference to trace metals. On the whole, seawater near effluent discharge point of two industries and harbour water was mildly polluted as compared to the seawater at reference locality. Longterm studies with specific reference to susceptible ecosystems in the area are necessary to determine the anthropogenic impact and remedial measures to be implemented.

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