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EFFECTS OF INDUSTRIAL EFFLUENTS (HEAVY METALS) ON SEA FOOD IN AND AROUND ISLAND OF MUMBAI (KHARDANDA AND URAN), MAHARASHTRA, INDIA

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Abstract:

Marine and coastal biological diversity (biodiversity) encompass an enormous variety of marine and coastal species, global oceans' myriad coastal and open sea habitats and a wealth of ecological processes. There are various ecosystems and species that are threatened as a result of self-destruction activities like over exploitation, pollution, reclamation etc. Rapid industrialisation has resulted in the destruction of habitats and the consequent extinction of several marine organisms. On the advent of industrial revolution, the coastal regions have become threatened by industrial pollution, and by habitat destruction because of dredging, sand mining, reclamation and rapid urbanisation.

Introduction:

Globally, human activities affect 83% of the land (Sanderson et al. 2002) and 100% of the ocean, with 41% being strongly affected (Halpern et al. 2008). As a result of our appropriation of resources and more direct impacts, an increasing number of species is threatened by extinction (Baillie et al.2004, Hails 2008, Secretariat of the Convention on Biological Diversity 2010).

Topography of the Environment Selected for Study

SITE No 1: KharDanda, Mumbai.

Mumbai is one of the metropolitan of India located on western sea coast of India. It now forms a collected mass of islands, trapezoid in shape and occupies an area of 437 sq km, which is about 0.14% of the total area of Maharashtra state. Mumbai city has rich natural resources of lakes, coastal water forests, wetlands and mangroves. Khar-Danda is a beach along its western edge which is polluted and unfit for swimming. It has a considerable amount of fishing area.

SITE No 2: Uran, Raigarh

Uran is a city and a municipal council near Mumbai in the Indian state of Maharashtra. Uran is part of the Navi Mumbai city township and lies in the Raigarh district.Uran is primarily a fishing village which has developed into a special economy zone. It has ample industries, namely JNPT, P&O and other shipping companies, GTPS, MSEB (Asia's first power plant run by gas), and ONGC.

SEZ in Uran:

Maharashtra was the first State to formulate a state level SEZ policy in 2001 and soon after that CIDCO proposed an SEZ spread over 3,800 hectares of land in Navi Mumbai region. Now named the Navi Mumbai SEZ (NMSEZ), it comprises of Dronagiri, Kalamboli, Ulwe and a regional park zone. NMSEZ is conceived and developed as a futuristic business hub and global gateway for trade, commerce, industry, service and tourism to India. It is also India's first SEZ in public private partnership, a joint venture with CIDCO, a Maharashtra Government undertaking.

Uran has a naval base near Mora village. Besides the naval base, the Oil and Natural Gas Corporation Limited (ONGC) has an Oil and Gas plant nearby. Once upon a time Uran was naturally a very beautiful Taluka but in last 10-15 years population has increased a lot and Uran is fast losing its charm.

The present study describes details of human impact on coastal ecosystem in and around Mumbai and throws light on responses of coastal resources to anthropogenic pressure.

Materials and Methods:

Sampling stations were selected based on the type of habitats. These habitats were characterized as enclosed docks, semi enclosed docks, ship building/repair docks, tidal berths, fishery jetty, recreational area, navigational channel, ship breaking yards, area of low circulation and potential sedimentation areas, etc. Sampling was carried out during December 2008 to December 2010, representing summer, monsoon and winter.

HEAVY METALS ANALYSIS

Reagents

The reagents used in the study were— nitric acid 69% (GR grade), hydrochloric acid 35% (GR grade), per chloric acid 70% (GR grade), stannous chloride ($SnCl_2$), potassium permanganate ($KMnO_4$), sulphuric acid

(H_2SO_4), hydrogen peroxide(H_2O_2), and double distilled water (Millipore).Instrumentation– voltammeter and digital cold vapour mercury analyzer.

Sampling:

The fish samples were collected and analysed during Dec-2009. Fish were collected from Khardanda and Uran Coast. Samples selected for heavy metal analysis were Mackerel (*R. Kanagurta*), Pomfret (*B. Brama*), Indian Salmon also called as Rawas (*E. Tetradactylum*) King fish also called as Surmai (*R.canadus*), and Brown prawns (*M.monoceros*). The samples were collected in sterile polythene bags and kept in the laboratory deep freezer (-20°C) to prevent deterioration till further analysis.

Sample pre-treatment (wet ashing)

Fish samples were cleaned with sterile distilled water and then dissected. Two grams of muscle tissue near the gill area of the fish was removed and weighed for the analysis of each metal. For estimation of arsenic content 2 g of muscle tissue was taken in a 100-ml Borosil beaker. To this, 2 ml of HNO_3 and 1 ml of $HClO_4$ was added and kept for digestion on a hot plate at 100◦C till complete digestion was achieved (Complete digestion involves removal of organic matter by reacting with acids.). It was ensured that the residue obtained after digestion was free from organic matter which acts as impurities in metal analysis (Khandekar et al. 1984; Raghunath et al. 1997). Residue was reconstituted using 1 M of 10 ml Hydrochloric acid (HCl) for further analysis on a voltammeter. Samples for estimation of lead, copper, and cadmium metals were also digested using the same protocol. For the analysis of mercury, 2 gm sample was placed into a 50-ml round bottom flask to which 2 ml nitric acid and 1 ml per chloric acid was added and then kept for digestion with the aid of condensation assembly for 2.5 h. Sample analysis Volta metric analysis of the digested samples of lead, copper, and cadmium was carried out using differential pulse anodic stripping voltammetry.

For the analysis of arsenic, square wave volta metric technique was used (Khandekar et al. 1984; Raghunath et al. 1997).The instrumental parameters used for this analysis are shown in Table 1.Mercury was analyzed on cold vapour mercury analyzer (MA5840, Electronic Corporation of India Ltd.). Two milliliters stannous chloride and 8 ml 10% HNO_3 was added in impinger containing sample to liberate the atomic mercury from the sample with constant stirring. Depending on the absorption values, the mercury content of the samples was calculated as reported earlier (Nriagu 1996; Farkas et al. 2000).

Sample analysis:

Volta metric analysis of the digested samples of lead, copper, and cadmium was carried out using differential pulse anodic stripping voltammeter. For the analysis of arsenic, square wave voltammetric technique was used (Khandekar et al. 1984; Raghunath et al. 1997).The instrumental parameters used for this analysis are shown in Table Mercury was analyzed on cold vapour mercury analyzer (MA5840, Electronic Corporation of India Ltd.). Two millilitres stannous chloride and 8ml10% HNO_3 was added in impinger containing sample to liberate the atomic mercury from the sample with constant stirring. Depending on the absorption values, the mercury content of the samples was calculated as reported earlier (Nriagu1996; Farkas et al. 2000).

Results:

Table 1 Levels of heavy metals in seafood from Khardanda during 2008-2009

Name of fish	Wt. of fish (g)	Pb	Cu	Cd	As	Hg
		μg/g	μg/g	μg/g	μg/g	μg/g
Prawn	4.78	0.017	0.07	0.013	0.02	0.004
Mackerel	92.21	0.013	0.6	0.019	0.04	1.78
Pomphret	80.6	0.015	0.67	0.014	0.016	1
King Fish	211.2	0.007	0.36	0.016	0.083	0.9
Indian Salmon	72.86	0.003	0.33	Traces	0.016	0.04

Table 2 Levels of heavy metals in seafood from Uran during 2008-09

Name of fish	Wt. of fish (g)	Pb	Cu	Cd	As	Hg
		μg/g	μg/g	μg/g	μg/g	μg/g
Prawn	10	0.037	2.5	Traces	0.008	0.07
Mackerel	96	0.24	0.07	0.01	0.01	0.095
Pomphret	52.2	0.033	0.18	Traces	0.024	0.039
King Fish	211.2	0.001	0.114	1.5	0.014	0.053
Indian Salmon	72.54	0.004	0.482	Traces	0.015	0.015

Table 3 Levels of heavy metals in seafood from Khardanda during 2009-10

Name of fish	Wt. of fish (g)	Pb µg/g	Cu µg/g	Cd µg/g	As µg/g	Hg µg/g
Prawn	4.70	0.015	0.06	0.011	0.01	0.002
Mackerel	90.20	0.011	0.4	0.016	0.03	1.30
Pomphret	81.15	0.017	0.62	0.016	0.012	0.80
King Fish	210	0.009	0.32	0.013	0.080	0.7
Indian Salmon	73	0.004	0.30	0.0012	0.04	0.05

Table 4 Levels of heavy metals in seafood from Uran during 2009-10

Name of fish	Wt. of fish (g)	Pb µg/g	Cu µg/g	Cd µg/g	As µg/g	Hg µg/g
Prawn	9	0.035	2.1	0.12	0.006	0.05
Mackerel	90	0.20	0.03	0.014	0.02	0.1
Pomphret	54	0.034	0.19	0.016	0.024	0.040
King Fish	208	0.002	0.116	1.6	0.016	0.054
Indian Salmon	72.30	0.006	0.475	1.0	0.016	0.017

Discussion:

Our study targeted the seafood, mainly fish [four varieties—*Bramabrama*(Pomphret), *Rachycentroncanadus*(Surmai / King Fish), *Rastrelligerkanagurta*(Mackerel), *Eleutheronematetradactylum* (Ravas / Indian salmon)] and prawns (*Metapenaeusmonoceros*) procured in and around the island of Mumbai. Five metals— lead, copper, cadmium, arsenic, and mercury were analyzed from fish brought to the shore from high seas and coastal waters.

In sea prawn at khardanda the value of lead is 0.017, for mackerel the copper content is 0.67, pomphret mercury level is about 1mug/gm. In king fish the values of cadmium is 0.016 and in Indian Salmon the arsenic is about 0.016mug/gm. (2008-09)

Heavy metals enter the aquatic environment naturally through weathering of the earth's crust. In addition to geological weathering, human activities have also introduced large quantities of metals to local water bodies, thereby disturbing the natural balance in the ecosystem (Forstner and Wittmann 1983). Over the past several decades, increasing use of metals in industry has led to serious environmental pollution through effluents and emanations (Goldberg et al. 1978; Phillips 1980; Sericano et al.1995).Under certain environmental conditions, heavy metals may accumulate to a toxic concentration (Guven et al. 1999) and cause ecological damage (Harms 1975; Jefferies and Freestone 1984; Freedman 1989).In uran in the present studies the values are more as compared to khardanda. In prawn the lead is 0.037,for mackerel 0.095,for pomphret arsenic is 0.024, for king fish mercury is 0.053 and for Indian Salmon copper is 0.482.(2008-09)

Industrial effluents, agricultural runoffs, transport, burning of fossil fuels, animal and human excretions, and geologic weathering and domestic waste contribute to the heavy metals in the water bodies (Erdogrul and Erbilir 2007).

Conclusions:

With the exception of occupational exposure, fish are acknowledged to be the single largest source of mercury and other heavy metals (cadmium, lead, and arsenic) affecting human beings. In some cases, fish catches were banned for human consumption because their total mercury content exceeded the maximum limits recommended by the Food and Agriculture Organization (FAO) and WorldHealth Organization (WHO). Reports indicate that contamination of Arabian Sea due to the industrial activity has led to the death of many species. Among seafood, fish are commonly consumed and, hence, are a connecting link for the transfer of toxic heavy metals in human beings (Waqar 2006).

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