

• **Perspectives and Commentary**

Hazardous Metal Pollution in the Republic of Fiji and the Need to Elicit Human Exposure

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The fact that hazardous metals do not bio-degrade or bio-deteriorate translates to long-lasting environmental effects. In the context of evidently rapid global industrialization, this ought to warrant serious caution, particularly in developing countries. In the Republic of Fiji, a developing country in the South Pacific, several different environmental studies over the past 20 years have shown levels of lead, copper, zinc and iron in sediments of the Suva Harbor to be 6.2, 3.9, 3.3 and 2.1 times more than the accepted background reference levels, respectively. High levels of mercury have also been reported in lagoon shellfish. These data inevitably warrant thorough assessment of the waste practices of industries located upstream from the estuaries, but in addition, an exposure and health impact assessment has never been conducted. Relevant government departments are duty-bound, at least to the general public that reside in and consume seafood from the vicinities of the Suva Harbor, to investigate possible human effects of the elevated hazardous metal concentrations found consistently in 20 years of surface sediment analysis. Furthermore, pollution of the intermediate food web with hazardous metals should be investigated, regardless of whether human effects are eventually confirmed present or not.

Keywords Developing countries, Fiji, Hazardous metals, Hazardous metal poisoning, Hazardous metal pollution, Industrialization

Environmental contamination with hazardous metals should raise concern because metals are not bio-degraded or bio-deteriorated over time like organic pollutants, resulting in long-standing environmental toxicity. In addition to the tendency to bio-accumulate and increase their concentrations over time, hazardous metals are also toxic at low concentrations. These facts ought to raise serious concern in the face of the current trend of global industrialization, particularly in developing countries.

Surface dumping of hazardous metals exposes them to air and rain, thereby generating much acid drainage. Pollution of farm-

land results in plants absorbing metals and accumulating them in their tissues. This ultimately results in accumulation of these toxins in tissues of animals and marine organisms, and in milk of lactating females [1]. Exposure in human beings results from consumption of contaminated water, plants and animal meat, which induce differential effects on the neurological system and also on human biochemistry. Essentially, all living organisms in any ecosystem are affected at their individual levels on the food chain [1].

We discuss in this paper the situation of hazardous metals in the environment, in the Republic of Fiji (hereafter called "Fiji"),

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a developing country in the South Pacific. Several studies have been conducted in Fiji intermittently over the past 20 years, analyzing environmental levels of a number of hazardous metals. Gangaiya et al. [2] reported in 2001 that copper, lead and zinc concentrations in sediments of certain sites within the Lami estuary were higher than other areas along Suva Harbor, previously considered to be highly contaminated. Maata and Singh [3] documented 7 years later of levels of lead, copper, zinc and iron in sediments of the Suva Harbor to be 6.2, 3.9, 3.3, and 2.1 times more than the accepted background reference levels, respectively. Morrison et al. [4] reported lagoon sediments and shellfish showing high levels of mercury. Chand et al. [5] reported levels of the metalloid arsenic in surficial sediments to be 334 mg/kg in dry weight, almost 30 times more than the USA's Environmental Protection Agency (EPA) cleanup guideline level for sediments of 12 mg/kg, and expected to pose ecological risks.

The history of Fiji shows that its people have primarily made their livelihood by utilizing marine resources within the vicinity of their dwelling areas. However, globalization and economic development over the years has also increased populations and industrialization of urban areas, resulting in over-utilization of marine resources, destruction of habitats, incorrect methods of waste management and depleted marine life [3]. The 2006 Fiji National Liquid Waste Management Strategic Plan reports these changes being significant in the industrial zone of Walu Bay due to high levels of tributyl tin from marine antifouling paints, petroleum pollutants, leached hazardous metals from a battery factory and effluents from nearby food processing factories [6].

Two prime industrial zones are located in the Suva Harbor comprising food-processing factories, a shipyard and large oil storage tanks. Within 3 km away on the coast lie the stinking remains of an open-style, non-segregated rubbish dump that used to accommodate 50,000 tons of all types of waste annually [3]. The dump was decommissioned in 2005 when waste had reached 15 m above ground level. Years of non-segregated, improper waste disposal has caused pesticides, oil and other hazardous pollutants and metals to leach into adjoining waters that flush freshwater into the harbor. Within a km west of this site, is an area of natural beauty that hosts a resort complex and a marina for visiting yachts. People living in the area also use the coastal stretch around this area for recreational purposes and for subsistence fishing [7].

All studies on environmental hazardous metal levels conducted in Fiji to date has been in various areas of the Suva Harbor, located on the south east of the main island. This area serves as a major commercial center with more than 150,000 people, one quarter of the population of the entire main island. Economic growth has resulted in progressive migration of the population

from rural to urban centers, associated with a corresponding escalation of environmental problems [3].

Despite all the available scientific data for Fiji confirming elevated levels of several hazardous metals in surficial sediments for the past 20 years, there have been no attempts to establish any effects in human populations, at least in those dwelling in the vicinities of the Suva Harbor. The regular Fijian still lacks a sense of responsibility towards the environment as is evident in the habit of casual trashing and spitting in public spaces, so it may not be overly presumptuous to assume that there is much less awareness of environmental pollution with hazardous metals. It would therefore also be unlikely that there is awareness of neither the bioaccumulation of hazardous metals nor the health effects of human exposure—an area that needs proactive attention and advocacy. Hazardous metal pollution data similar to Fiji's is provided by the South Pacific Regional Environment Program for the neighboring countries of the Solomon Islands, Tahiti, Papua New Guinea and Vanuatu, showing elevated surficial sediment and shellfish concentrations of hazardous metals [8]. Similar to the situation in Fiji, it is also probably unlikely that the general population is aware or informed.

Exposure to hazardous metals is associated with various conditions such as developmental retardation, cancers, kidney failure, autoimmunity, and even death if exposed to very high concentrations [1]. Autoimmunity has been associated with development of diseases of the joint, renal, circulatory and central nervous systems. Lead primarily has neurotoxic effects to which children are more susceptible than adults because they absorb more and excrete less of the lead that their bodies have been exposed to. Relatively more of the retained lead is deposited in the brain, and it causes more damage to the developing brains of children than to mature brains [1].

In a similar manner, the most significant health effect of methylmercury in fetuses, infants, and children is impaired development of the central nervous system. Consumption of methylmercury-contaminated fish and shellfish by a pregnant woman has deleterious effects on the developing fetal neurological system that results in impaired memory, cognition, concentration span, language and fine motor and visuo-spatial skills [1].

There is indeed room for argument in the premises of this paper because it makes reference to hazardous metal levels in surface sediment as the basis for extrapolating a hypothesis of probable human effects. O'Connor and Paulb [9] compared US EPA Environmental Monitoring and Assessment Program Estuaries Program data with bio-effects data on sediment chemistry and toxicity reported by the National Oceanic and Atmospheric Agency, and they could not find any one indicator that accurately predicted toxicity. This finding questions the appropriateness

and reliability of using sediment data as a monitoring tool for contamination and probably deserves more investigation. Eliciting levels of the metabolites and breakdown products of these contaminants may be a valid alternative, as they become the main source of toxicity once the parent compound is no longer detectable. Nevertheless, until an accurate, reliable alternative is developed, surface sediment will continue to provide relevant data on marine environmental health.

It is evident that globalization is pressuring countries into economic development, but industrialization in developing nations like Fiji commonly occurs at the expense of the environment; the release of hazardous metals into the environment should therefore not be expected to reach a plateau anytime soon. Existing environmental data that conclusively prove considerable contamination of the Suva Harbor with various hazardous metals warrant the need for thorough assessment of the waste practices of industries located upstream from the estuaries, but it is also timely that metal contamination of the human food chain and consequent biological effects were investigated. Analyses for hazardous metals in soil, water, dust and where indicated, root crops and vegetables, of proximal residential dwellings need to be considered. Government, non-government and academic institutions with mandates or interest to investigate hazardous metal pollution of the environment should be encouraged to collaborate with the ministry of health and its affiliates in linking this aspect of environmental health to human health. With the effects of climate change already evident in Fiji and its smaller neighboring states, this collaborative proposal provides the added opportunity to address the knowledge gap by raising awareness in the general public about the less-known but vital connections between the environment and human health.

The same proposal is relevant and can be applied to neighboring countries in the Pacific region as well, but for now, the need to conduct exposure and health impact assessments in regards hazardous metals in Fiji, especially in women and children, is pertinent and pressing.

Conflict of Interest

The authors have no conflicts of interest with the material presented in this paper.

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