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Pollution Trends in India—Evidence for the Need of an Environmental Specimen Bank

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Abstract—The research work done by the Center for Marine Environmental Studies (CMES), Ehime University, Japan for the past three decades in India on its pollution scenario shows the need for every concern and a coordinated effort from the viewpoint of global pollution sources of persistent chemicals in the country. Our past and present results obtained through analyses of freshly collected as well as archived samples in our *es*-BANK shows the possibility of using the status of pollution in the environmental and biological matrices of India as tracers and indicators of global pollution. Clear spatial and temporal variations in the levels of persistent chemicals like DDTs, HCHs, CHLs, HCB, PCBs, dioxins and related compounds (DRCs), brominated flame retardants (BFRs) like PBDEs and HBCDs, etc. were noticed. Further, the vast data source that we have gathered through our past and present studies indicates, in the absence necessary facilities and manpower to monitor the toxic chemicals at present, there is a need for the establishment of at least a pilot scale specimen bank in India, to archive the biological and environmental samples for future use.

Keywords: India, pollution status, Specimen Bank

INTRODUCTION

India is the seventh largest country in the world and the second largest in Asia with an area of 3.28 million square km. In a land mass of 2.4% of the total area of the world, India supports over 15% of the world population and also five percent of the world's life forms. The wildlife population of this mega biodiversity nation comprises over 75,000 animal species which include 300 species of mammals and 1,200 species of birds, the most vulnerable creatures of the nature to organic pollutants. Indian temperature and monsoonal changes are very complex and Indian monsoons are components of large scale circulation system; both these facilitates the global circulation of several volatile and semi-volatile chemicals, by the mechanisms shown by Wania and Makay (1993) while explaining the global transport of chemicals. Further, being a typical agrarian state India has been using large quantities of agrochemicals. The use of industrial chemicals has also been increasing at a faster rate than the other countries with similar

economies.

India, at present is a growing hub for the information technology, providing opportunities in urban areas, leading to large scale urbanization and addition of various chemicals to their ambient environments. Apart from this, thousands of solid waste municipal dumping sites and electrical and electronic waste (e-waste) processing areas in India are contributing the legacy and emerging Persistent Organic Pollutants (POPs) and also trace elements to the environment as well as biota. As a result, it seems that India at present forms a wonderful hub for studying the global pollution scenario. There are varieties of changes in the pollution scenario of the country in the past three decades because of the facts mentioned above. The scientists from Ehime University, Japan have started their efforts on surveying the pollution status of India from the late 1980s, which is still continuing.

RESEARCH SURVEYS BY CMES SCIENTISTS IN INDIA

The 1980s–1990s

The multitude of scientific publications and popular articles appeared during the last three decades on Indian pollution scenario did not attract much attention of the public as well as the government of India. The toxicity of chlorinated hydrocarbon insecticide poisoning in Indian human subjects had been shown as early as in 1975 (Gupta, 1975) and the existence of pesticides in the Indian environment has been reported two decades before (Gupta, 1985). Apart from this, only limited works has been carried out on the continental region of India during the 1980s. The findings by Tanabe and Tatsukawa (1980) on the chlorinated hydrocarbons (PCBs, DDTs and HCHs) in the air and surface waters of the North Pacific, Bering Sea, East China Sea, South China Sea, Bay of Bengal, Arabian Sea and Indian Ocean found remarkably high concentrations of DDTs and HCHs in the air off the western coast of India, substantiating the possible prominent transport of such chemicals from India to the surrounding seas and far beyond.

Later, the first ever planned sampling on the continental region of India was undertaken in the year 1987 by Ehime University scientists, during which they have collected samples of water, soil, sediment and biota in collaboration with Annamalai University, India, followed by several such sampling trips together with the scientists of many institutes spread all over India. The results of the analyses of many of those samples and the pesticide spray experiments carried out in Indian paddy fields revealed multitude of interesting distribution and transport patterns of the pesticide chemicals like HCHs, DDTs, and also the industrial chemical PCBs (Ramesh *et al*., 1989, 1990a, 1990b; Tanabe *et al*., 1991) in India. An interesting experiment conducted by Takeoka *et al*. (1991) in a riverine and estuarine structure of South India showed the possible rapid contamination by HCH in global terms via long-range atmospheric transport from the point-source areas in India. Very high ratio of atmospheric transport, high temperature and heavy rainfall indicates an accelerated rapid removal of residues. Further, it could be noted that the situations existing in the tropical country like India may

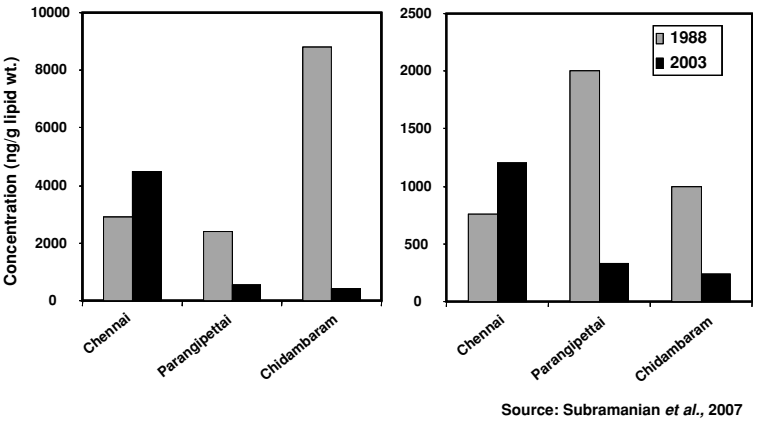

Fig. 1. Temporal changes of HCHs and DDTs in human milk from some locations in Tamil Nadu State, India.

considerably alter the global contamination by persistent toxic substances.

These reports were followed by publications on the occurrence of these compounds in the Indian environment and biota (Kannan *et al*., 1992). Later, Iwata *et al*. (1993) found continuous flux of HCHs from air to water in Bay of Bengal and Arabian Sea thus receiving higher amounts of organic chemicals from India via atmosphere. This has been followed by publication showing various POPs chemicals in Indian mothers' milk (Tanabe *et al*., 1990), mussels (Ramesh *et al*., 1990a), samples from paddy field (Tanabe *et al*., 1991), various food items (Kannan *et al*., 1992), wildlife (Ramesh *et al*., 1992), dolphins (Tanabe *et al*., 1993), river dolphins (Senthilkumar *et al*., 1999a), bats (Senthilkumar *et al*., 1999b) and birds (Tanabe *et al*., 1998). Following this, in the late 1990s, the scientists from CMES concentrated their efforts on the levels of other organic compounds such as butyl tins (BTs) in Indian samples such as mussels (Tanabe *et al*., 2000) and birds (Senthilkumar *et al*., 1998). The related works carried out by the collaborating scientists from India also revealed widespread contamination by POPs in India (Babu Rajendran *et al*., 1994; Subramanian *et al*., 1999).

After 2000

Later, the continued works taken up by CMES scientists on Indian samples in the 21st century on organochlorine pesticides and PCBs showed remarkable variations like reduction in the levels of classical organochlorines as a result of the various bans and restrictions imposed by government of India on their manufacture and usage (Senthilkumar *et al*., 2001; Kunisue *et al*., 2003; Kannan *et al*., 2005; Subramanian *et al*., 2007; Devanathan *et al*., 2009) (Fig. 1). Apart from evaluating the temporal and spatial variations of persistent chemicals in India, the efforts of CMES scientists also focused on some specialized

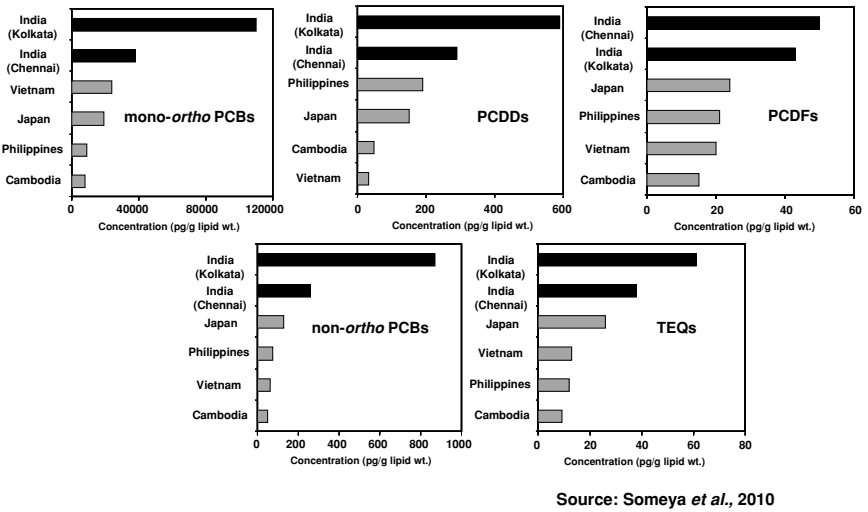

Fig. 2. Comparison of DRC concentrations in breast milk of mothers living near the municipal solid waste dumping site in Kolkata, India with Chennai (India) dumping site and other Asian developing countries.

environments like the municipal solid waste dumping sites which are now proved by their works as possible hubs of global pollution by toxic chemicals like dioxins and related compounds (DRCs) (Kunisue *et al*., 2004; Watanabe *et al*., 2005; Minh *et al*., 2006). The levels of PCDDs/DFs and TEQs (Fig. 2) were found to be higher in the milk of mothers living in and around the municipal dumping sites of India (Someya *et al*., 2010) when compared with some other Asian developing countries indicating the importance of India in assessing the global pollution status of these compounds.

Apart from these the recent works by CMES has shown that the e-waste processing sites are becoming the sources of pollution by the novel POPs chemicals like brominated flame retardants (BFRs) such as PBDEs and HBCDs (Eguchi *et al*., 2009). Kajiwara *et al*. (2006) found these compounds in the bodies of small cetaceans caught from Indian coastal waters and Ramu *et al*. (2007) found their presence in the coastal waters of India. Further, the soil samples from these sites were found to be sources of several heavy metals (Ha *et al*., 2009) thus leading to heavy metal accumulation in human hair of the workers in backyard e-waste sites (Ha, unpublished). Agusa *et al*. (2003) also saw lead pollution in several samples of India.

ONGOING RESEARCH

The ongoing research at CMES laboratories shows the presence of PBDEs in Indian human milk of common public (Sudaryanto *et al*., 2005), whereas the work by Devanathan (unpublished) shows that the milk from Indian mothers

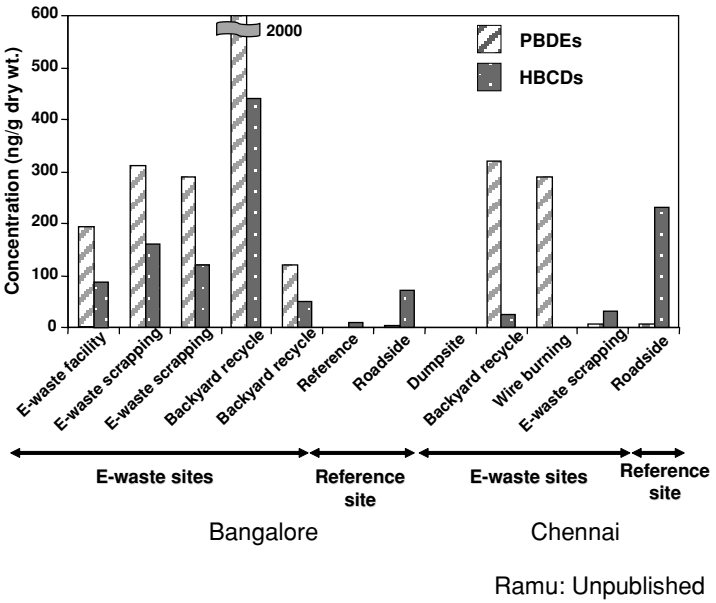

Fig. 3. Concentrations of PBDEs and HBCDs in soils from e-waste sites in India (Ramu, unpublished data).

collected during the year 2009 had PCBs levels lower than those found in our previous samples (Tanabe *et al*., 1990) whereas the PBDEs in the samples collected during 2009 showed an increasing trend than in the samples collected during 2004 (Sudaryanto *et al*., 2005). Further, the survey work carried out by Ramu (unpublished) shows that PBDEs and HBCDs do occur in the soil and human hair samples collected from the e-waste processing sites in Bangalore and Chennai, the two metropolitan cities in South India. The concentrations in the samples collected from the e-waste areas, especially in the backyard processing sites, were found to be relatively higher than in the control sites (Fig. 3), indicating that these novel POPs compounds are increasing in the environment and biota, at least near the source areas. The present situation in India seems to indicate that, the levels of classical POPs is decreasing but at the same time the levels of novel POPs like PBDEs are increasing.

NEED FOR AN ENVIRONMENTAL SPECIMEN BANK

The data pool on pollutants in India available at CMES indicates clear spatial and temporal variations and possible global transport patterns. At present the *es*-BANK at Ehime University has a store of about 5000 samples from India, which is very minimal while considering the vastness of this mega biodiversity nation. Our results obtained from the specimens archived in our specimen bank showed the possibility of using the status of pollution in the environmental and biological

matrices of India, as indicators of global pollution scenario. In spite of these, the interest shown by the concerned agencies in India is very minimal for reasons obvious. Effort by the Indian scientific community should be stimulated in a systematic and coordinated fashion. Millions of valuable specimens gathered every year by thousands of scientists working in hundreds of scientific institutions in India are not kept for long for want of adequate storage facilities, thus loosing the links in the pollution histories of chemicals in India and hence their global scenario. There are institutions and cities having all the necessary infrastructure facilities for establishing an environmental specimen bank. Efforts may be taken up by interested developed nation scientists/government of India by providing necessary training, man-power and financial assistance to establish a pilot specimen bank at Chennai, the south Indian metropolis, a hub of scientific and commercial activities and also having rich biodiversity in its surrounding areas.

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