Negombo Lagoon:
A Potential Mercury Hot Spot in Sri Lanka

Report by
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Negombo Lagoon – a Potential Mercury Hot Spot in Sri Lanka

IPEN Mercury-Free Campaign Report

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Introduction

In 2009, the Governing Council of the United Nations Environment Programme (UNEP GC) decided to develop a global legally binding instrument on mercury to reduce risks to human health and the environment (UNEP GC25/5). The UNEP GC noted that mercury is a substance of global concern due to its long-range transport, persistence, ability to bioaccumulate, and toxicity. Its conclusions were based in part on the 2002 UNEP Global Mercury Assessment which noted that mercury is present in fish all over the globe at levels that adversely affect humans and wildlife. (UNEP 2002) Mercury is present in different forms but the organic form of mercury, methylmercury, is especially toxic to humans and wildlife because it is readily absorbed by the body and accumulates in blood and tissue. In humans, hair is widely accepted as a matrix for reliable estimations of the body burden of methylmercury, which likely comes from eating fish (Grandjean, Weihe et al. 1998); (Harada, Nakachi et al. 1999); (Knobeloch, Gliori et al. 2007); (Myers, Davidson et al. 2000).

This report focuses on a Negombo lagoon as transition point of wastes and waste waters generated in larger area surrounding this lagoon. Negombo lagoon (GPS- 7^0 $07^{'}$ 53.42''N 79^0 51' 09.93''E) is located in the western province of Sri Lanka, 32 km north of Colombo.

Thirteen samples of fish were collected in lagoon and hair samples were collected in Negombo city on the North edge of the lagoon to confirm whether the waste and waste waters produced in the area resulted in food source contamination of fish and also had potentially influenced levels of mercury in local population of people. In addition, since local mercury releases become global problems due to long range transport we considered how the treaty text will address mercury content in wastes and waste water discharges such as in larger Negombo region.

Materials and methods

National NGO Center for Environmental Justice (CEJ) conducted fish and hair sampling in Negombo region. In total thirteen samples of fish of the two fish species (10 of the long whiskers cat fish and 3 of the mullet fish s. Liza) were caught in collaboration with local fisherman using protocols developed by the Biodiversity Research Institute (BRI 2011). CEJ conducted sampling of human hair using protocols developed by IPEN (2011). Sixteen hair samples were taken in total for this study – fourteen in the Negombo city, one in Gampaha and one in Matara. Biodiversity Research Institute (BRI) measured mercury levels (total mercury content = THg) in both fish and hair samples in its laboratory in Gorham, Maine,

USA. CEJ characterized the studied area and provided information about its history and presumptive mercury sources.

Results and discussion

The Negombo lagoon is the transition point of all waste generated in the area. Being surrounded by many industries, due to untreated waste water generated by various industries pasing through the canals the lagoon does accumulate a significant amount of pollutants (Samath 1998); (Malawaraaratchi 2003). In addition to the waste water coming from Biyagama and Katunayaka industrial zones, the domestic waste water also add pollutants to the water way. All these waters pass through the lagoon.

The fresh water bodies received by the lagoon include Attanagalu oya which connects to the lagoon as the Dandugam oya and the Ja Ela at the southern tip of the lagoon, rainfall and occasionally water due to high flood of Kalu oya and the Kelani ganga. Muthurajawela, the swampy brackish water tidal delta at the southern tip of the lagoon also contributes to the fresh water budget of the lagoon (Silva 1996). Lesser amounts of water are received through the Hamilton canal at the northern tip of the lagoon.

Even though a size of the accumulation or contamination could not be described, the study carried out by Silva, on water quality of Sri Lanka, indicates, the water received through Dandugam oya and Ja Ela can be highly contaminated due to direct and indirect discharges of untreated waste water from Ekala trade processing zone (Silva 1996).

For this study, two fish species were sampled from three different localities. Two species mullet fish s. Liza and long whiskers cat fish were caught in Katunayaka in the middle part of the lagoon while on the north mouth of the lagoon in Munnakkara and Negombo only long whiskers cat fish was sampled. Table 1 shows the levels of mercury (Hg) in each locality and type of fish.

Table 1: Mercury content of fish sampled in Negombo lagoon.

	Sample Size	**Hg Average (ppm, ww)**	**St Dev**	**Min Hg (ppm)**	**Max Hg (ppm)**	**Reference dose[a] (ppm)**	**Fraction of samples over Ref. Dose**
Katunayaka – cat fish	3	0.167	0.094	0.105	0.275	0.22	33%
Katunayaka – mullet Liza	3	0.018	0.004	0.014	0.021	0.22	0%
Munnakkara – cat fish	4	0.098	0.035	0.049	0.134	0.22	0%
Negombo – cat fish	3	0.107	0.038	0.073	0.149	0.22	0%
All fish samples	13	0.097	0.070	0.014	0.275	0.22	8%

Abbreviations: Hg, mercury; ppm, parts per million or mg/kg; ww, wet weight; min, minimum; max, maximum

[a] Figure derived from the reference dose used as U.S. EPA consumption guidelines for fish (0.2 $mg.kg^{-1}$ methylmercury) based on the presumption that methylmercury counts for 90% of THg levels, limit value used by Canada is similar . Japan and/or UK use 0.3 reference dose. Source: US EPA (2001). Water Quality Criterion for the Protection of Human Health: Methylmercury. Final. EPA-823-R-01-001, Office of Science and Technology, Office of Water, U.S. Environmental Protection Agency Washington, DC**:** 303.

Table 1 shows that average mercury levels in cat fish from Katanayaka was highest among sampled fish while levels of mercury in the same species from Negombo and Munnakkara were lower. Lowest levels were observed in mullet fish s. Liza from Katanayaka. Mercury level exceeded the US EPA reference dose in one sample from total 13 fish caught in Negombo lagoon.

Table 2 shows the levels of mercury in hair samples from larger Negombo City. There were only two samples taken outside this area in Wele Watta, Matara respective Ihalayagoda, Gampaha with observed mercury levels of 0.81 ppm respective 1.19 ppm. There is also comparison of different locations within Negombo City: Pitipana, Thaladuwa and other parts (Munnakkara and Thalahena).

The average level of THg in the hair of all 14 volunteers from Negombo City was two-times higher than the US EPA reference dose. Approximately four-fifths of the samples exceeded the reference dose. The maximum level of THg in hair was almost 4.5-times higher than the reference dose. There was no clear difference of THg concentrations in hair between two larger groups from Pitipana and Thaladuwa, however levels in hair of participants from Thaladuwa were slightly higher. There is no simple explanation to that, however difference is not big, and number of participants was not enough large for more comprehensive comparison between these two groups.

Table 2: Mercury content in hair samples from Negombo City larger area.

	Sample Size	**Hg Mean (ppm)**	**St Dev**	**Min Hg (ppm)**	**Max Hg (ppm)**	**Reference dose (ppm)[b]**	**Fraction of samples over Ref. Dose**
Pitipana[c]	6	2.065	1.214	0.777	3.734	1.00	83%
Thaladuwa	6	2.128	1.520	0.896	4.450	1.00	67%
Other parts	2	2.403	1.384	1.424	3.381	1.00	100%
All hair samples	14	2.140	1.271	0.777	4.450	1.00	79%

Abbreviations: Hg, mercury; ppm, parts per million or mg/kg; st dev, std deviation; min, minimum; max, maximum

It is clear that levels of Hg in hair are high in comparison with those observed in fish in this report. We looked at diet of volunteers for hair samples and all of them eat fish almost every day and six of them are fishermen. Fish is most likely major reason for high levels of mercury in hair of volunteers in this report although fish sampled in this report didn't show high levels in most of samples. One of the reasons might be that total number of samples couldn't show real situation within the lagoon, there were higher levels of Hg observed in other two fish species in study from 2008 (Indrajith, Pathiratne et al. 2008)[d]. Also significant number of

[b] U.S. EPA's RfD is associated with a blood mercury concentration of 4-5 μg/L and a hair mercury concentration of approximately 1μg/g." US EPA (1997). Mercury study report to Congress, Volume IV, An assessment of exposure to mercury in the United States. EPA-452/R-97-006**:** 293.

[c] It includes both Pitipana and Pitipana North.

[d] Hg 0.03 – 0.33 ppm – in the green chromide (Etroplus suratensis), 0.04 – 0.26 ppm in common glassfish (Ambassis commersoni) in muscles, while in liver and gills were higher levels.

volunteers (6 of total 14) prefers other fish species for their diet than those sampled in this study. Some of them prefer to eat rather sea fish species (e.g. sail fish, rabbitfish or grouper) than brackish water fish presented in this report.

The recorded level of mercury in the lagoon in 1996 was <0.02 ppm (Silva 1996), however this is higher than 0.01 ppm, the tolerance limit for mercury given by the Central Environmental Authority for discharges in to marine coastal waters or 0.0005 ppm, the permissible level for industrial waste discharges in to inland surface waters (Government of Sri Lanka 2008).

A high amount of mercury had been recorded in a study on coastal sediments from Mannar (200 km north from Negombo). The level of mercury in marshland peaty sediments was indicated as 95 ppm while that of sediments from tidal flats of Mannar was 8 ppm. It also report in intertidal sediments mercury can exist bound to grain coatings of Fe-Mn-oxides, hydrates and to undecomposed organic matter (Senaratne and Dissanayake 1989).

Previous studies on mercury in fish from Sri Lanka focused rather on sea fish species. Senadheera, in his analysis on mercury contamination in selected food fish carried out in 2002, recorded levels from 0.03 – 0.47 ppm with a highest mean level of mercury contamination in *Xiphias gladius (*sword fish) with a value of 0.22 ppm ww. Also in *Carcharhinus limbatus (Shark)* the levels ranged from 0.06-0.45 ppm ww. Lower levels were in tuna fish and in *Makira indica*, 0.05 respective 0.04 ppm ww (Senadheera 2005).

Another study in 2010 confirmed the accumulation of mercury is high in sword fish (1.24±0.72 ppm) while yellow fin tuna was recorded with 0.39 ± 0.19 ppm and red snapper with 0.17± 0.06 (Jinadasa, Edirisinghe et al. 2010); (Jinadasa, Rameesha et al. 2010).

Conclusions and recommendations

Levels of mercury in hair of volunteers in this report raise concerns about health impact of potential levels of mercury in fish consumed by people living on islands as Sri Lanka, although we are not able to give clear answer about one potential source of their exposure to mercury levels. Similar situation was observed on Cook Islands in one of previous IPEN's studies published in January 2013 (ISACI, CACP et al. 2013).

Although levels of mercury found in fish in this study doesn't show too high levels, there were higher levels of mercury observed in some previous studies focused on Negombo lagoon (Indrajith, Pathiratne et al. 2008) or in sea fish species caught in Sri Lanka (Jinadasa, Edirisinghe et al. 2010); (Jinadasa, Rameesha et al. 2010). We suggest look at Hg levels in fish from larger surrounding of Negombo City more closely, because the levels of mercury in hair raise the concerns and there are potential sources of mercury discharges into waters of both Negombo lagoon and nearby sea waters.

It provokes questions about how the future mercury treaty might mandate actions to eliminate mercury pollution of the environment and fish from waste waters and/or minimize global emissions of mercury in order to make world safe for islanders who rely on fishing resources for their preferred source of protein. It is therefore imperative to prevent continuous mercury pollution of the ocean, in order to avoid impacts on human health and the marine environment.

“IPEN has held that, at a minimum, a global treaty on mercury should be expected to incorporate provisions that if taken together and fully implemented, will actually reduce total anthropogenic mercury emissions and releases to the global environment. In our view, the present treaty is not sufficient to do this.” (IPEN Heavy Metals Working Group 2013)

This study also shows the need to look more closely on potential levels of mercury in fish species consumed by population in Negombo and to address potential mercury pollution sources of ocean and brackish ecosystems in Sri Lanka. Best tool for that might be kind of National Implementation Plan on Mercury, however it is only voluntary now according proposed text of the treaty (UNEP (DTIE) 2013).

Sunderland and Mason (2007) have suggested that open ocean mercury concentrations will increase if anthropogenic mercury emissions remain at their present level. As oceans and seas are polluted not only by mercury deposition from air, but also by mercury bound in sediments from rivers it is important to look how the mercury treaty text addresses mercury releases to water. Currently the treaty text offers some vague options for controlling releases to land and water (IPEN Heavy Metals Working Group 2013).

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