

Coal-fired power plant and pulp and paper mill site: Tha Tum Mercury Hot Spot in Thailand

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). 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 coal-fired power plant and pulp and paper mill in Tha Tum, Thailand, which are part of the Prachinburi Province's largest industrial complex located 120 km to the East-North-East from Bangkok, and 5.5 km south from the Prachinburi River. Coal contains mercury that is released into the environment when the coal is burned. Air emissions from poorly controlled plants can emit large quantities of particle-bound mercury which tends to fall to earth downwind of these power plants. Mercury in fly ash which is captured by air pollution control devices can also be subsequently released to the environment. Pulp and paper plants can be another mercury source when phenyl mercury acetate is added to inhibit the growth of fungi and contaminates the discharge water.

Fish and hair samples were collected close to the Tha Tum industrial site to confirm whether the coal-fired power plant and/or pulp and paper mill had potentially influenced levels of mercury in the local population of people and fish. In addition, since local mercury releases become global problems due to long range transport we considered how the draft treaty text will address coal-fired power plants as well as the pulp and paper industry. Fish were collected from the Shalongwaeng canal in the Srimahaphot district and hair was sampled among residents from the Moo2 and Moo3, Tha Tum sub-district.

Materials and methods

Thai NGO, EARTH, conducted fish and hair sampling. Twenty samples of common snakehead were caught in collaboration with local fisherman using protocols developed by the Biodiversity Research Institute (2011). For sampling of human hair EARTH used protocols developed by IPEN (2011). BRI measured mercury levels (total mercury content = THg) in both fish and hair samples their laboratory in Gorham, Maine, USA. EARTH characterized the hotspot site and provided information about its history and presumptive mercury sources.

Results and discussion

Tha Tum is a rural municipality that is facing rapid industrial growth and expansion. Over the past decade, local residents have filed various complaints about air, water and noise pollution – including coal dust from the open-air storage piles from the power plant, constant odor from the pulp mill, and massive amounts of dead fish in public canals almost every year.

The industrial complex consists of 75 factories in an area of 12 square kilometers in Tha Tum called the 304 Industrial Park. This industrial complex includes a 400 MW coal-fired power plant consuming 900,000 tons/year of coal and a pulp and paper mill producing 500,000 tons/year of paper. The power plant uses coal and biomass, i.e. rice husk and wood bark, for fuel. The scope of mercury releases from power plants depends in general on the content of mercury in fuel (UNEP 2005) as well as air pollution control processes, neither of which were examined for this report. Pulp and paper mills can be significant sources of mercury releases especially to effluents (Beim and Grosheva 1992); (Kim, Park et al. 2010).

For this study, 20 samples of common snakehead fish (*Channa striata*) were sampled in two different year periods from the Shalongwaeng Canal (17 samples) and surrounding swamps (3 samples). Table 1 shows the levels of mercury (Hg) in all samples.

Table 1: Mercury content of fish sampled in Shalongwaeng Canal and swamps close to a coal-fired power plant and pulp and paper mill in Tha Tum, Thailand.

	Sample Size	Hg Mean (ppm, ww)	St Dev	Min Hg (ppm)	Max Hg (ppm)	Reference dose ^a (ppm)	Fraction of samples over Reference Dose	Limit(s) ^b (ppm)
Common snakehead	20	0.341	0.111	0.067	0.526	0.22	85%	0.02

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

Table 1 shows that the mean mercury level in common snakehead fish samples exceeded the US EPA reference dose of 0.22 ppm, and 85% of all samples were above this level. All samples were above the contaminant standard set up in Thailand (UNEP 2002). Mercury concentrations in common snakehead also are not related to the fish's total length (see Figure 1 below), suggesting that it is not possible to use the criterion of the size of fish in an advisory for local people.

There is lack of recent studies of mercury in animal tissue of water ecosystems in Thailand and studies from the period before 2000 were more focused on the marine environment.

^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.

^b Limit for mercury in freshwater fish applied in Thailand as Food Containing Contaminant Standard. Ministry of Public Health Announcement Number 98 in 1986 allows for no more than 0.02 mg/kg of mercury in food. Source: UNEP (2002). Global Mercury Assessment. Geneva, Switzerland, UNEP: 258.

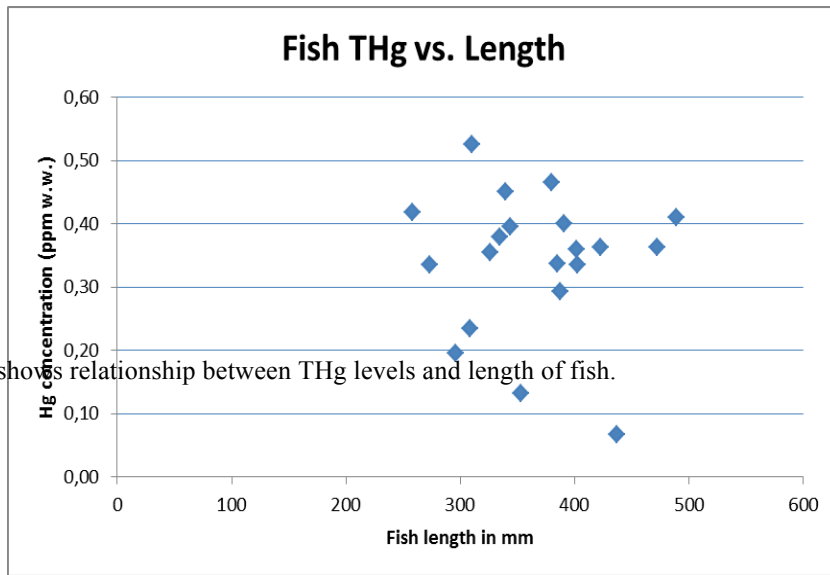


Figure 1: Graph shows relationship between THg levels and length of fish.

One study by the Pollution Control Department monitored the level of mercury and other heavy metals in coastal sediment and marine animal tissue around the mouth of the major rivers which flow into the Gulf of Thailand (Marine Pollution Subdivision - Pollution Control Department (PCD) - Ministry of Natural Resources and Environment 1998). The study found 0.063 mg/kg (wet weight) of mercury in

mullet fish tissue, 0.014 mg/kg of mercury in mackerel, and 0.02 mg/kg or less of mercury in shrimps and mussels.

Most recently in September 2012, after requests and complaints by many residents, Nong Bua Rural Municipality in Baan Kai District, Rayong Province collected fish tissue samples from Pla Glang Canal and tested for cadmium, lead and mercury. Sampling results showed no contamination of cadmium or lead, but samples showed mercury levels ranging from <0.024 to 0.073 ppm of Hg (Central Laboratory (Thailand) Co. Ltd. 2012).

Levels of mercury in fish from the vicinity of Tha Tum were much higher in comparison with Nong Bua in Baan Kai District and are rather comparable to levels of mercury in fish from contaminated natural gas production areas in Gulf of Thailand caught at Erawan and Funan platforms at levels higher than 0.5 ppm observed there in the 1990s (Cheevaporn and Menasveta 2003).

One likely mercury pathway into the Shalongwaeng Canal is from fly ash from the coal-fired power plant and coal dust from the open-air storage piles. In addition, there is the possibility that contaminated wastewater from the pulp mill may leak into Shalongwaeng Canal.

The Shalongwaeng Canal flows into Prachinburi River, which merges into the Nakhon Nayok River to be the Bang Pakong River. The Bang Pakong River was found among rivers which exhibit high concentrations of most heavy metals in green mussels at their mouths by Rojanavipart (1990). This study suggested that *“the contamination by heavy metals in the inner Gulf of Thailand would be more severe if preventive measures were not taken promptly.”* Data in our study show that problem of contamination by heavy metals in certain Thai rivers is at least still as serious, if not worse.

Table 2 shows the levels of mercury (Hg) in hair samples from Moo2 and Moo3 villages in Tha Tum in the neighborhood of power plant and pulp and paper mill at a distance of 0.5 -2 km.

Table 2: Mercury content in hair samples from Tha Tum, Thailand

	Sample Size	Hg Mean (ppm)	St Dev	Min Hg (ppm)	Max Hg (ppm)	Reference dose (ppm) ^c	Fraction of samples over Reference Dose
Moo2 and Moo3; Tha Tum	20	4.595	2.692	1.628	12.758	1.00	100%

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

The average level of mercury in the hair of all 20 volunteers from Moo 2 and Moo 3 villages in Tha Tum was more than 4.5-times higher than the US EPA reference dose and all individual samples exceeded the reference dose. The maximum level of mercury in hair was more than 12.5-times higher than the reference dose. We examined the relationship between the age of volunteers (18 – 72 years), the number of fish meals they eat per week (options from less than 1 up to more than 8 meals per week), and levels of mercury in their hair. In general, levels of mercury depend on both of these criteria and rise with age and number of fish meals per week. However, the maximum mercury level was not found in hair of the oldest volunteer, but in a person eating the common snakehead fish very often.

Every household consumes local freshwater fish as a part of their daily diet, due to widespread availability and importance for nutrition. This also explains the relatively high levels of mercury in hair of people living in Tha Tum.

There is a shortage of environmental pollution data in Thailand. To date, Thailand has not conducted a complex survey of heavy metal pollution sources. Nonetheless, Prachinburi Province (where Tha Tum is located) is listed as having the fourth highest number of patients with illnesses from industrial hazardous chemicals, according to the Annual Pollution Report 2011 (Pollution Control Department (PCD) - Ministry of Natural Resources and Environment 2011).

One study in 2008 by EARTH (formerly as Campaign for Alternative Industry Network or CAIN) in Kalasin Province, north-eastern Thailand, found high level of mercury (0.70 ppm) in the soil near a recycling and burning site for electronic products (Saetang and et al. 2008).

Fish samples collected near the caustic soda factory of TACSCO in Thailand during November and December 1978 were found to contain 0.10 to 1.38 ppm Hg in flesh (on wet weight basis), whereas those of the control areas contained 0.01 to 0.30 ppm (Suckcharoen, Nuorteva et al. 1978). In the same study Suckcharoen, Nuorteva et al. (1978) also looked at mercury levels in hair. The mean mercury level was 2.3 ppm and 2.9 from area polluted by a chlor-alkali plant. There was a difference in hair samples of males and females in the vicinity of the plant. Mercury content in the hair of males was significantly elevated comparing to

^c 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.

females, whose hair samples did not show elevated levels. In another study Sukcharoen (1978) found high levels of mercury in *Ipomoea aquatica*, a commonly used vegetable and a pig food in Thailand from the same chlor-alkali plant area. This set of studies is in agreement with our findings which show elevated levels in both fish and hair samples. Mean mercury levels in hair from Tha Tum in this study are higher than those observed by Sukcharoen in the late 1970s in the vicinity of chlor-alkali plant in Thailand.

Coal-fired power plants, pulp and paper mills and the mercury treaty

The Tha Tum site pollution of fish and human hair by mercury demonstrated in this study provokes questions about how the mercury treaty might mandate actions to eliminate mercury pollution of the environment and fish from power plants and the pulp and paper industry.

Mercury emission inventories suggest that coal-fired power plants are a major source of mercury air releases (Pirrone, Cinnirella et al. 2010); (UNEP Chemicals Branch 2008), however their contribution to mercury releases into water as well as wastes is often overlooked. Also the question of how pulp and paper plants contribute to water ecosystem pollution by mercury arose in relation to the Tha Tum hotspot in Thailand. Both power plants and the pulp and paper industry are missing on the list of “Source categories of releases of mercury and mercury compounds to land and water“ in current text of mercury treaty (UNEP (DTIE) 2012).^d Pulp and paper production is not listed as the source of air emissions in current treaty text (UNEP (DTIE) 2012),^e although the Mercury Toolkit (UNEP 2005) and US TRI data suggest it is a significant source of air emissions (TRI 2004).

The current treaty text on air emissions offers some vague options for controlling existing coal-fired power plants if they are above a certain thermal input (not yet determined). However these provisions are not likely to reduce mercury emissions from individual plants on a scale sufficient to offset the new mercury emissions that are likely to result from the rapid growth of this sector.

To prevent continuous mercury pollution of water ecosystems, especially fish serving as food for the local community and tourists in Thailand it is necessary to prevent further releases from such sources as coal-fired power plants and pulp and paper mills. Until this problem is addressed, mercury will continue to contaminate both the local area and contribute to global mercury pollution.

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^d UNEP(DTIE)/Hg/INC.5/3; Pulp & paper and coal firing power plants are missing on the list in Annex G: Source categories of releases of mercury and mercury compounds to land and water.

^e UNEP(DTIE)/Hg/INC.5/3; Pulp & paper is missing on the list in Annex F: List of sources of emissions of mercury and its compounds to the atmosphere.

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