Mercury (Hg) concentrations in our food supply: The untold story

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Background

One of the most well known mercury exposure disasters was the Minamata Bay disaster in Japan in 1956. Minamata is a small industrial town on the coast of Shiranui sea. The Chisso Corporation, which is a major industrial firm in Minamata, dumped 37 tons of mercury into Minamata Bay from 1932 to 1968. As a result, many of the residents whose diets included fish from the bay, developed symptoms of methyl mercury poisoning, including birth defects and death. Since this disaster, government agencies began to issue warnings about eating fish that contained high levels of mercury. Globally, 143.8 million tonnes of seafood is consumed (Guillen 2018)

USEPA's Safe Limit: < 0.1 ug of mercury per kilogram of body weight per day.

A 176-pound (80 kg) person should consume no more than 8 ug of mercury per day.

Li et al. (2018)

Changed the mercury exposure paradigm beyond fish; Yui et al. (2018) showed that vegetables grown downwind of an atmospheric mercury source had elevated Hg concentrations

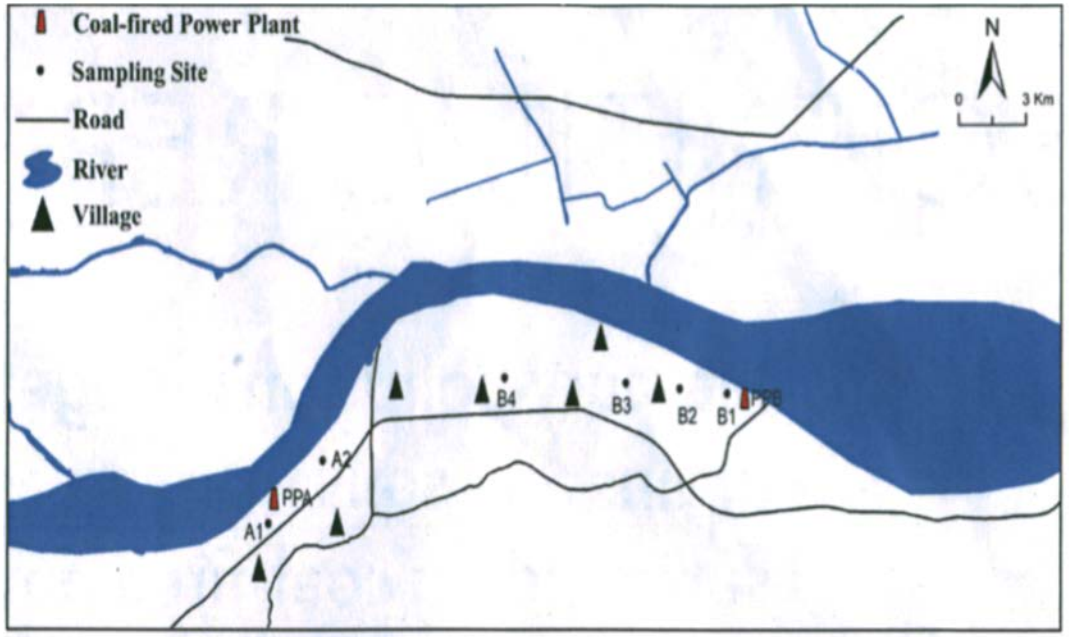
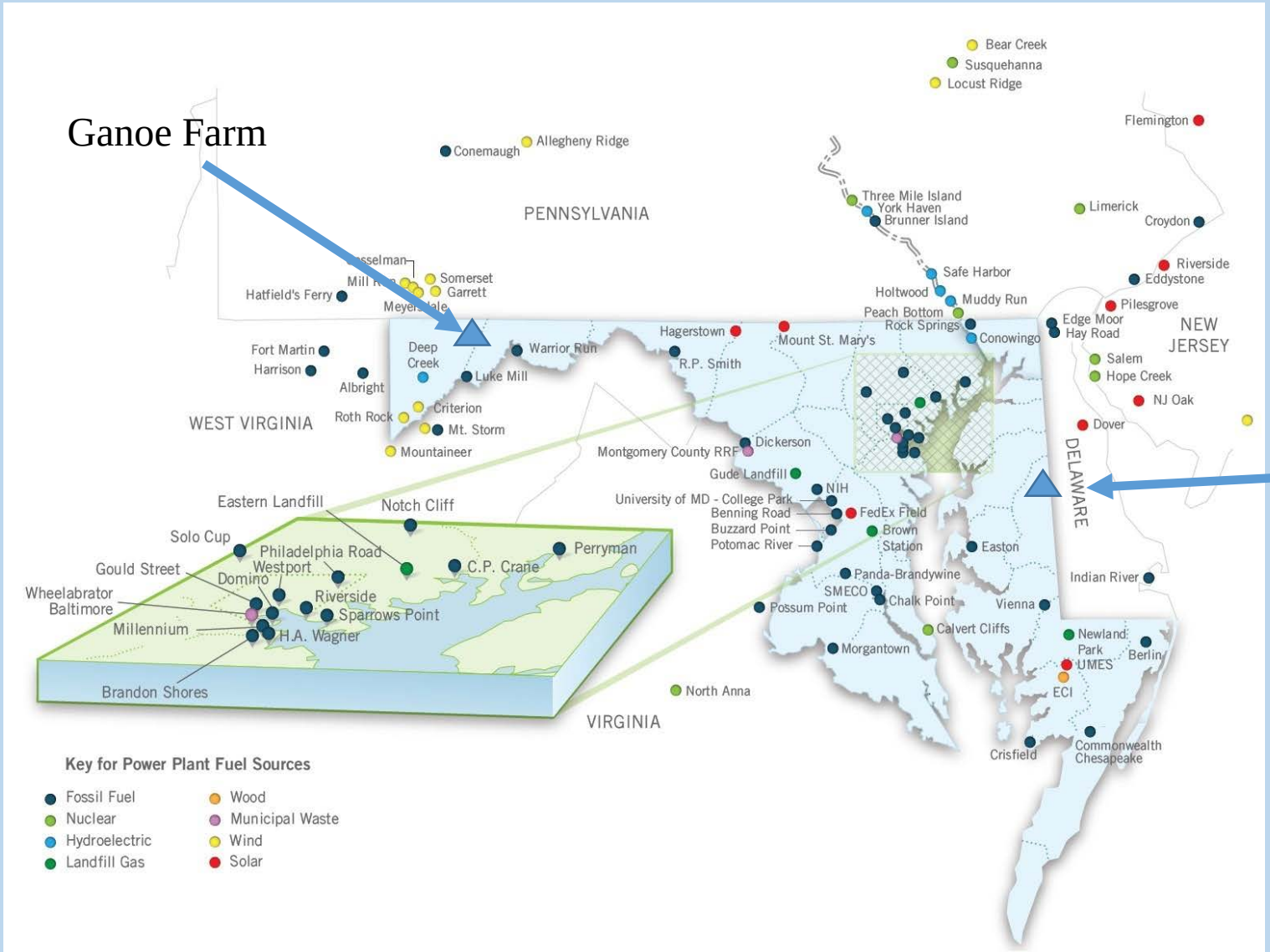


Figure 1. Plant and soil sampling sites around Power Plant A and Power Plant B. Black triangle: villages. PPA: Power Plant A; PPB: Power Plant B; A1: 1 km from Power Plant A; A2: 3 km from Power Plant A; B1: 1 km from Power Plant B; B2: 3 km from Power Plant B; B3: 5 km from Power Plant B; B4: 10 km from both Power Plants A and B.

Samples		Location B1	Location B2	Location B3	Location B4	Control Sample*
Leaf Vegatables	Lettuce	21.03 +/- 0.16*	19.41 +/- 1.16*	9.17 +/- 0.52*	7.23 +/- 0.57*	0.35 +/- 0.10
	Spinach	54.46 +/- 4.55*	49.19 +/- 0.28*	38.97 +/- 3.43*	23.88 +/- 1.28*	0.85 +/- 0.22
Fruit Vegtables	Tomato	76.33 +/- 5.47*	57.09 +/- 8.33*	29.07 +/- 1.45*	9.79 +/- 0.43*	0.73 +/- 0.36
Grain	Corn	21.18 +/- 0.67*	4.68 +/- 0.707*	1.06 +/- 0.08*	0.55 +/- 0.08*	0.72 +/- 0.19

Do vegetables grown in Maryland contain detectable concentrations of Hg?

Our two study farms and power plants in Maryland



Objectives

- To improve our understanding of the mercury concentrations in locally grown corn and soybeans.

- To analyze the levels of mercury in fruits, vegetables, and fish sold in local grocery stores.

Methods

Microwave Digestion

- 0.250 grams of pulverized vegetable, fruits, grains, and fish were placed into Teflon vessels. 10 mL of Nitric acid was then added to each sample vessel.
- The sample digestions were based on EPA method 7473 and analyzed using a Microwave Sample Preparation System.

Total Mercury Analysis

- After digestion, 100uL of each sample was pipetted into 45mL sample vials
- EPA method 1631. This consisted of adding 100 uL of sample to 24.685mL of DI water, 0.125mL of BrCl, 0.03mL of Hydrolxamine (HH) and 0.06mL of SnCl2.
- Tekran 2600 Mercury Analyzer

Total Mercury Concentrations

Components	Marydel Control (ng/g dry weight)	Marydel Treatment (ng/g dry weight)	Ganoe Farm Garrett County (ng/g dry weight)
Corn Husk	2.6	1.4 and 1.1	1.6
Corn Leaves		15.7 and 10.8	9.2
Soils attached to Roots	37.7 and 43.6	49.1	23.8
Roots	17.8	24.0 and 22.7	24.2
Corn	0.6	0.25 and 0.20	0.19
Soybeans	0.40 and 0.39		

Mercury in food

Food	Average size (g)	Concentration (ng/g)	Amount of mercury consumed (ug)
Apple (1 medium size apple)	70	8.4 +/- 2.1	0.59
Carrot (1 6 inch carrot)	70	8.6 +/- 0.3	0.6
Tomato (1 medium size tomato)	170.1	4.2 +/- 2.3	0.71
Lettuce (1 cup of lettuce)	128	11.9 +/- 2.7	1.5
Spinach (1 cup of raw spinach)	128	27.7 +/- 7.7	3.5
Potato (1 medium size apple)	150	25.7 +/- 6.7	3.8
Total (just vegetables)	716		10.8
Tilapia (recommended serving of fish)	138.91	15.2 +/- 2.0	2.1
Tuna (1 can of tuna)	141.75	278.0 +/- 1.5	39.4
Total (Tilipia and vegetables)	857.75		12.9
Total (Tuna and vegetables)	280.66		50.2

Mercury in dog biscuits

9.2 ± 0.4 ng Hg/g

One small biscuit equals 680 grams

6,256 ng of Hg per biscuit

Do vegetables grown in Maryland contain detectable concentrations of Hg?

Yes

Acknowledgments

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Health Risks of Hg^0, Hg^{+2} and CH_3Hg

- *Elemental mercury* is a neurotoxin that impacts the central nervous system. Some neurological effects are tremors, irritability, loss of coordination and slurred speech. Very high exposures can cause kidney effects, respiratory failure and death.
- *Inorganic mercury* is the least toxic of the three forms of mercury. It can damage the gastrointestinal tract, as well as the kidneys and nervous systems. High exposures can lead to skin rashes, muscle weakness and memory loss.
- *Organic mercury* can cause damage to the central nervous system and neurological problems. Extreme exposures can lead to death.