Report by
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Mercury in Fish and Hair Samples from Batroun, Lebanon

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IPEN Mercury-Free Campaign Report

Prepared by IndyACT (Lebanon), Arnika Association (Czech Republic) and the IPEN Heavy Metals Working Group

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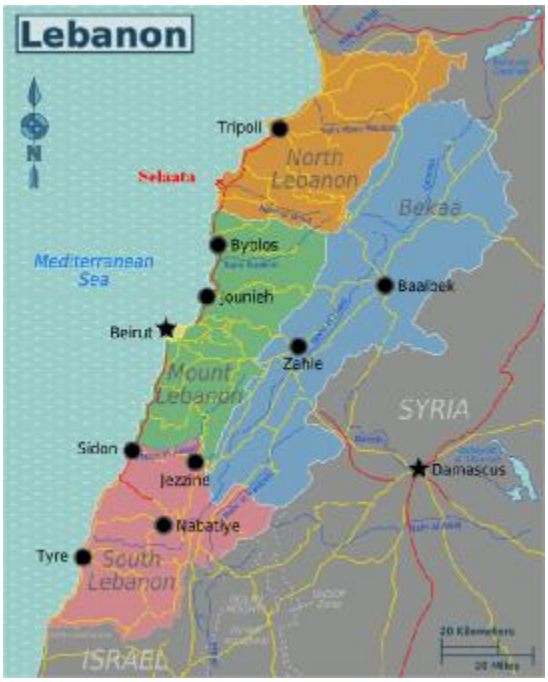
Introduction

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 Selaata and near city Batroun in Lebanon, where Lebanese NGO IndyACT sampled fish and human hair for mercury analyses.

Picture 1: Location of Selaata harbor.

Picture 2: Map of Lebanon with marked location of Selaata



There is a phosphate fertilizer plant (Lebanon Chemical Company, LCC) located in Selaata harbor (see snapshot from Google Earth at picture 1). Batroun is a city located 4 km to the south from Selaata. Both are in North governorate of Lebanon (see map at picture 2).

Materials and methods

National NGO IndyACT conducted fish and hair sampling in Selaata-Batroun region. In total thirteen samples of fish of the two fish species (10 of the dusky grouper and 3 of the mottled grouper) were caught in collaboration with local fisherman in Mediterranean Sea near Batroun using protocols developed by the Biodiversity Research Institute (BRI 2011). IndyACT conducted sampling of human hair using protocols developed by IPEN (2011). Sixteen hair samples were taken in total for this study in Batroun City larger area south and southeast from Selaata chemical plant area. Biodiversity Research Institute (BRI) measured mercury levels (total mercury content = THg) in both fish and hair samples in their laboratory in Gorham, Maine, USA. IndyACT characterized the studied area and provided information about its history and other relevant information.

Results and discussion

The fertilizer factory emits different pollutants that are harmful for health and environment such as phosphogypsum, heavy metals and radionuclides via water and air pathways as well as its fertilizer products. The site has been subject to several environmental studies (Brigden, Santillo et al. 2002); (Abi-Ghanem, Nakhlé et al. 2011); (Kodeih 2011). We try to look closely at levels of mercury in this region, although it is not suspected to be a major pollutant discharged from the factory.

Table 1 shows that average mercury levels in fish samples from Mediterranean Sea near Batroun was 0.157 ppm ww and levels of mercury in three samples of dusky grouper exceeded the US EPA reference dose.

Table 1: Mercury content in fish sampled in Mediterranean Sea near Batroun, Lebanon.

	Sample Size	**Hg Average (ppm, ww)**	**St Dev**	**Min Hg (ppm)**	**Max Hg (ppm)**	**Reference dose[a] (ppm)**	**Fraction of samples over Ref. Dose**
Dusky grouper	10	0.185	0.096	0.092	0.393	0.22	30%
Mottled grouper	3	0.064	0.033	0.033	0.115	0.22	0%
All fish samples	13	0.157	0.100	0.033	0.393	0.22	23%

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

Table 2 shows the levels of mercury (Hg) in hair samples from larger Batroun City area. The average level of THg in the hair of all 16 volunteers from Batroun area was 0.332 ppm which

[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.

is below the US EPA reference dose. Only one sample had level of THg higher than US EPA reference dose.

Table 2: Mercury content in hair samples from Batroun, Lebanon.

	Sample Size	Hg Mean (ppm)	St Dev	Min Hg (ppm)	Max Hg (ppm)	Reference dose (ppm)[b]	Fraction of samples over Ref. Dose
Batroun[c]	11	0.329	0.319	0.039	1.158	1.00	10%
Dhoum - Batroun	2	0.134	0.057	0.093	0.174	1.00	0%
Other parts of Batroun[d]	3	0.476	0.183	0.476	0.671	1.00	0%
All hair samples	16	0.332	0.286	0.039	1.158	1.00	6%

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

In 1985, 13 different species of fish were caught along the Lebanese coast from the capital Beirut to the southern city of Tyre. Mercury from *"0.028 mg/kg of wet tissue for Siganus rivulatus to 0.054 mg/kg for Mullus barbatus"* were found (Harakeh, Acra et al. 1985).

Another study was conducted by the research Council at the University of Balamand, where 94 fish samples were collected from Lebanese markets to test their mercury levels, which *"ranged from 0.0190 to 0.5700 ug/g in fresh samples, 0.0059 to 0.0665 ug/g in frozen samples, and 0.0305 to 0.1190 ug/g in canned samples."* The study revealed that it was the local fresh fish that had the highest mercury levels: yellowstripe barracuda/Sphyraena chrysotaenia), sargus (white seabream/Diplodus sargus), ghobbos (bogue/Boops hoops), and shrimp (Penaeus sp.) were among the types containing the highest amounts of mercury (Obeid, El-Khoury et al. 2011).

Certain amounts of mercury can be released with the waste water of the fertilizer factory. In a study of mercury contamination in coastal sediments, total mercury concentrations in Selaata varied from 20 to 60 ng/g dw. Although these concentrations are of lower order, there is evidence for enrichment of mercury in some sediment layers (Abi-Ghanem et al. 2011). For comparison there were found total mercury concentrations in sediments from 1 to 219 ng/g dw from South Florida Estuaries (Kannan, Smith et al. 1998).

In May 2011, mercury concentrations in the air have been measured twice in the area of Selaata. Measures were taken about 200 m southeast of the fertilizer factory. The first time, mercury concentration in atmospheric air varied between 64.5 - 67.7 ng/m^3. The second measurement at the same place showed a concentration varying between 1.3 - 2.5 ng/m^3. These levels are lower than those measured in vicinity of some chlor-alkali plants in Europe (Kuncova 2008) which reached more than 20-times higher levels.

[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] Volunteers reported Batroun as their residence.

[d] It includes Koubba, Selaata and Aakaybeh.

The fertilizer factory uses phosphate rock whose mercury content varies by origin. The phosphate is imported from Syria and contains approximately 44 to 66 ng/g of mercury. Some of the mercury existing in the raw material is emitted into the air. Another source of mercury contamination is the burning of fossil fuels for energy (Kodeih 2011).

We also compared our results with some previous studies focused on exposure of Lebanese population to heavy metals and their findings are similar. *„The exposure assessment conducted places Lebanon among countries least exposed to heavy metals through the diet"* (Nasreddine, Hwalla et al. 2006). Also according our research among volunteers for hair sampling they eat fish less often (less than one fish meal per week in most cases) than in some other countries who were part of IPEN's research like e.g. in Thailand (more than 6 fish meals per week); (EARTH, Arnika Association et al. 2013). This finding is in agreement with study by Nasreddine, Nashalian et al. (2010), in which fish was minor exposure pathway for heavy metals in diet, because it is not so large portion of the diet in Lebanon. This explains difference between the level of mercury in some fish species, which can raise concerns and mercury levels in hair lower than US EPA dose in most of cases among 16 volunteers in this study.

Conclusions and recommendations

In comparison with localities like for example chlor-alkali plants (Information Center Volgograd Eco-Press, Eco-Accord et al. 2013); (Arnika Association and IPEN Heavy Metals Working Group 2013) or contaminated sites (Eden Center, Arnika Association et al. 2013) in some other countries included in this round of studies mercury levels observed in both fish and hair are relatively low, however levels in dusky grouper exceeded US EPA reference dose in 30% and raise concerns about potential risks for consumers of this fish. Potential sources of mercury in the environment should be better monitored in Lebanon and addressed in potential National Implementation Plan to future Mercury Convention, , however it is only voluntary now according proposed text of the treaty (UNEP (DTIE) 2013). Results of this study are in agreement with some other results of mercury measurements in the area.

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