

MERCURY IN MADRE DE DIOS

MERCURY CONCENTRATIONS IN FISH AND HUMANS IN PUERTO MALDONADO

CAMEP
CARNEGIE AMAZON MERCURY ECOSYSTEM PROJECT

CAMEP

Research Brief #1

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A new study of fish and humans in the Peruvian Amazon finds that mercury is a serious and increasing environmental and public health problem in the gold mining region of Madre de Dios. High mercury concentrations found in a majority of people and in most of the wild caught fish sold in markets in the capitol city, Puerto Maldonado, indicate that the scope and intensity of mercury contamination by artisanal gold mining in Madre de Dios is greater than previously thought.

Introduction

Mercury is a powerful neurotoxin and a persistent environmental contaminant that accumulates in the tissues of fish in regions where artisanal scale gold mining exists. Consuming contaminated fish is one of the primary mercury exposure pathways for humans living in these regions. A previous study conducted in 2009 by the Carnegie Institution for Science's Department of Global Ecology found that many of the consumed fish species sold in the markets of Madre de Dios, an Amazonian region in southern Peru, had levels of mercury well above international reference limits. This indicated a serious public health and environmental problem existed in the Western Amazon.

To better understand how mercury from artisanal gold mining is affecting ecosystems and human populations, in 2012 the Carnegie Institution for Science established the *Carnegie Amazon Mercury Ecosystem Project (CAMEP)*, a scientific research effort that brings together 8 Peruvian universities and NGOs with Carnegie scientists to focus on the pressing problem of mercury in Madre de Dios.

This first CAMEP research brief presents the results of two studies that examined the effects of mercury on the urban community of Puerto Maldonado, the capital city of the department of Madre De Dios.

Research Design

CAMEP researchers analyzed the mercury concentrations of the muscle tissue of 15 species of commonly consumed wild caught fish which were purchased in several markets in Puerto Maldonado during August 2012. To determine the effect of eating these fish and the levels of general mercury exposure of the population, the CAMEP project offered free mercury hair testing to 226 adults in Puerto Maldonado during May to August 2012. A survey was given to the participants, asking about fish consumption and mercury exposure history. These fish and hair samples were analyzed for total mercury at a dedicated mercury analysis laboratory established at the Environmental and Computational Chemistry Group at the University of Cartagena, Colombia.

Major Findings

Mercury in Fish

60% of the species of fish sold in in Puerto Maldonado had mercury levels that exceeded international mercury concentration limits for fish. Mercury levels of 9 of the 15 most consumed fish species had average levels of mercury above the international mercury reference limit (0.3 ppm).

Carnivorous fish species located high on the food chain had the highest mercury levels while species lower on the food chain had the lower mercury concentrations. Fish raised in the growing industry of fish farms generally had low mercury concentrations (figure 1).

Mercury levels increased in 90% of fish species between 2009 and 2012.

Average mercury levels increased in 10 of 11 (90%) fish species analyzed between 2009 and 2012 including in species with mercury concentrations below the international mercury reference limit indicating that the aquatic ecosystems, the rivers and lakes in which these fish live, are increasingly impacted by mercury released by artisanal gold mining activity in Madre de Dios.

Mercury In Humans

78% of adults in Puerto Maldonado had hair mercury concentrations above international mercury reference limits for human hair.

More than three out of four adults analyzed in Puerto Maldonado had mercury concentrations higher than the reference limit. Average mercury concentrations of adults were 2.7 ppm – almost three times the reference value of 1 ppm (figure 2). Mercury levels in human hair ranged from 0.02 ppm to a high of 27.4 ppm, a level more than 27 times the international limit for mercury in human hair.

Figure 1. Average levels of mercury in consumed fish in Puerto Maldonado, compared to the reference limit for mercury in fish (0,3 ppm).

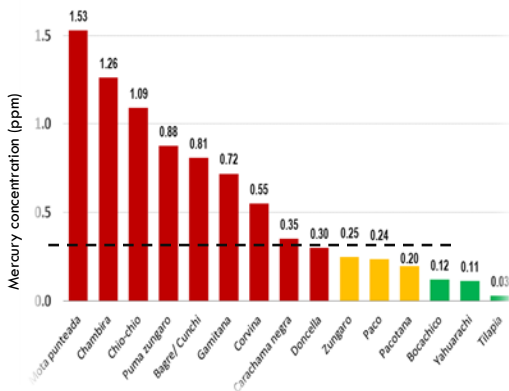
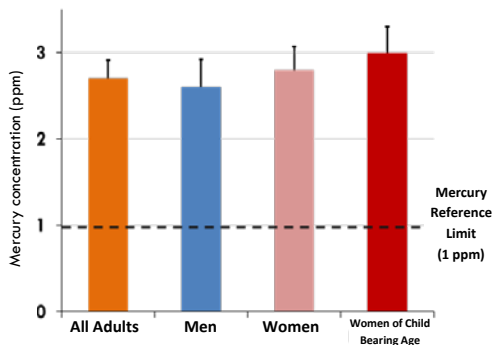


Figure 2. Mercury levels of 226 adults in Puerto Maldonado, compared to the reference limit for mercury in human hair (1,0 ppm).



Reference Values

Mercury in Fish Tissue

0,3 ppm US Environmental Protection Agency (USEPA) Mercury Reference Concentration (RfC) Fish, 2001

Mercury in Human Hair

1,0 ppm US Environmental Protection Agency (USEPA) Mercury Reference Concentration (RfC) Human Hair, 2001

ppm = parts per million (µg/g) Hg

The most vulnerable population, Women of Child Bearing Age, had the highest average mercury levels.

Women of child bearing age (between 16-49), a group most at risk from the neurotoxic effects of mercury, had the highest hair mercury levels of adults in Puerto Maldonado with average levels of 3.0 ppm (figure 2, red column). Women of child bearing age are particularly at risk because mercury can be passed to the developing fetus across the placental barrier and cause severe and permanent neurological damage to the unborn child.

The human population of Puerto Maldonado has a very high risk of mercury exposure and associated health effects due to high consumption of local contaminated fish, experience in gold mining, and from inhalation of airborne mercury from gold buying shops.

The majority of participants (92%) in Puerto Maldonado reported that they consume local river and lake fish regularly. 64% of respondents said they consume at least one high mercury species weekly, while 25% eat two or more on a weekly basis. Occupational exposure is also an important factor, as 25% of adults report working directly in gold mining. Lastly, the study results indicate that another significant exposure source of mercury exists in Puerto Maldonado and is contributing to the extremely high levels of mercury found in the adults of Puerto Maldonado. Suspected sources are the gold buying shops located in the center of Puerto Maldonado that release large amounts of mercury vapor, exposing thousands of people daily to toxic air levels.

Summary of findings

1. High levels of mercury in the environment of Madre de Dios are strongly affecting the human population of Puerto Maldonado, resulting in a grave and mounting threat to public health.
2. Mercury levels of the people of Puerto Maldonado are extremely elevated and mercury contamination is more extensive than previously identified.
3. Mercury contamination of wild caught fish sold in the markets of Puerto Maldonado is much more extensive than previously identified and is increasing, indicating that the ecosystems of Madre de Dios are becoming more severely affected by artisanal gold mining.
4. Regular consumption of wild caught fish species contaminated with high concentrations of mercury and occupational exposure to mercury through gold mining is contributing to the high levels of mercury found in adults in Puerto Maldonado.
5. Other sources of mercury, such as the high levels of mercury vapor released by "gold shops", small businesses that buy and refine gold in populated urban areas, are also contributing to the high mercury levels found in people.

Research Sponsors

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CAMEP Research Partners

Universities and Research Institutions

Carnegie Institution for Science – Global Ecology
 Universidad Nacional Amazonica de Madre de Dios
 Universidad de San Martin de Porras – Instituto Del Peru
 Universidad de Cartagena – Grupo de Química Ambiental y Computacional

Non-governmental Organizations

Asociación para la Conservación de la Cuenca Amazónica
 Asociación para la Investigación y el Desarrollo Integral
 Asociación Huarayo
 Caritas Peru – Madre de Dios
 Consorcio Madre de Dios
 Sociedad Zoológica de Frankfurt Perú

Carnegie Institution for Science

The Department of Global Ecology, founded in 2002 on the campus of Stanford University located in Palo Alto, California, USA, conducts basic and applied research on the interactions among the earth's ecosystems, land, atmosphere, and oceans. For more information, see: dge.stanford.edu.

Carnegie Amazon Mercury Ecosystem Project

Established in 2012, the Carnegie Amazon Mercury Ecosystem Project (CAMEP) brings together researchers of eight Peruvian universities, non-governmental organizations, and Carnegie Institution for Science to conduct ecological and public health studies over the issue of mercury in the region of Madre de Dios, Peru.

For More Information

Luis E. Fernandez, Director, CAMEP
luisf@stanford.edu

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