MERCURY EXPOSURE OF WOMEN IN TWO LATIN AMERICAN GOLD MINING COUNTRIES

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Cover photos:
top: Gold mining sluice barge near a hair sampling site in Peru; bottom left: ASGM tailings dump near a hair sampling location in Peru; bottom right: Taking a hair sample from a participant

FOREWORD

By Marcos Orellana

PROTECT HUMAN RIGHTS, BAN THE MERCURY TRADE

Mercury contamination continues to undermine the rights to life, health and a clean, healthy and sustainable environment of Indigenous peoples, workers, children and local communities around the world. By far, the main contributor to mercury pollution globally is the use of mercury in small-scale gold mining. It is time to prohibit the trade in, and use of, mercury for the sake of our health and the health of our planet.

As this latest IPEN study exposes, Indigenous women in Peru and Nicaragua that live where small-scale gold mining takes place have high levels of mercury in their bodies. This has troubling consequences for them, and if they become pregnant, they can result in potentially lifelong cognitive deficits and/or physical malformations for their children.

The human rights and environmental injustices caused by mercury use in small-scale gold mining have been widely documented. The ongoing allowable use of mercury in small-scale gold mining is compromising the right to clean food sources of millions of people around the world.

Unfortunately, the threats posed by mercury are only increasing. There is a growing flow of mercury into the rainforests of the Amazon basin, the villages and rivers of Indonesia, the gold mining towns along the banks of Lake Victoria in Kenya, Uganda and the United Republic of Tanzania, and many other locations.

In most parts of the world where mercury is used in small-scale gold mining, the human rights of miners, their families and communities, often living in abject poverty, are increasingly threatened by mercury contamination. Indigenous peoples are particularly affected by the persistent mercury pollution of their territories, deforestation, loss of biodiversity and contamination of their food sources. Children are disproportionately impacted by slavery-like conditions and dangerous work in the mines, sexual exploitation, and exposure to mercury.

While the global scope of this problem is beyond dispute, some argue that banning mercury use in small-scale gold mining would impair the livelihoods of many people who have no immediate alternative. But this argument professes to favor the poor by maintaining status quo policies that harm them, while the downstream gold industry profits. The actual harm caused by mercury use in small-scale gold mining to human rights and the environment of countless individuals, communities, peoples, ecosystems and future generations cannot be justified by the economic gains of the mining industry or the poverty of miners. Everyone has the right to an adequate standard of living, but no one has the right to harm the health or physical integrity of others to earn a living.

The Minamata Convention on Mercury is a robust agreement which aims to protect human health and the environment from emissions and releases of mercury. Despite its strengths, however, the Convention has gaps and shortcomings that limit its effectiveness in reducing and eliminating mercury use in what is the largest source of emissions and releases to the environment, namely small-scale gold mining. The Convention regards small-scale gold mining as an allowed use of mercury, and therefore trade in mercury destined for such mining remains legal.

Thus, driven by the increasing demand from gold-importing countries, mercury releases and emissions from the small-scale gold mining sector have continued to increase, adversely affecting the human rights of vulnerable individuals, groups and peoples. The Minamata tragedy over 70 years ago shows that mercury contaminated sites and health impacts of mercury exposure have very high costs and long-lasting effects.

To more effectively combat human rights violations related to the use of mercury in small-scale gold mining and protect the environment, States and the Convention should prohibit the use and trade of mercury in such mining. Several States have already taken this step and are starting to collaborate to confront this form of environmental crime.

Banning trade in mercury will be an essential step towards strengthening the Convention and keep its promise of no more Minamatas anywhere in the world.

KEY FINDINGS

- Mercury is a potent neurotoxin that can affect the central nervous system of the developing fetus months after the mother's exposure. The harmful effects can be passed from the mother to the fetus, including neurological impairment, IQ loss, and damage to the kidneys and the cardiovascular system. It is commonly used in small-scale gold mining, which is the leading source of global mercury pollution.
- Hair samples from Indigenous women of childbearing age in four communities in Peru and two communities in Nicaragua were tested for mercury as an indicator of their mercury body burden. The women all live along rivers near small-scale gold mining operations (sometimes called "artisanal" small-scale gold mining or ASGM), where mercury use is common, and all rely on fish from those waterways for dietary protein.
- Of the 105 Indigenous women of childbearing age who participated in this study, levels of mercury in 92 women (88%) exceeded the current 1 ppm US EPA threshold level beyond which negative effects may be detected in a developing fetus of a pregnant woman, and levels in 104 women (99%) exceeded the 0.58 ppm level, which is a recently derived level proposed by numerous experts due to evidence of potential harmful effects from lower levels of mercury on the cognitive development of the fetus.
- The women of the four Peruvian Indigenous communities where sampling took place had highly elevated levels of mercury in their hair with a mean of 3.40 ppm ± 2.08 ppm fresh weight (fw). On average, this exceeds the current threshold level for harmful effects on a developing fetus of a pregnant woman by more than three times. The current 1 ppm reference level and the 0.58 ppm proposed level for mercury were exceeded in 54 participants (98%) from Peru. Of the Peruvian women, 39 participants (70%) had mercury levels more than twice the current safe level, 14 (25%) had levels more than four times higher, and 7 (12%) had levels more than six times higher. The highest level recorded was found in hair from a woman in Community 1 at more than nine times above the current level for potential fetal harm (9.44 ppm).
- The Peruvian Indigenous women who participated do not engage directly in gold mining but do eat fish as the mainstay of their diet, so it is inferred that their high mercury body burden arises from consuming mercury contaminated fish of the Madre De Dios River system. Previous studies have attributed this fish contamination to small-scale gold mining using mercury.
- The women of the Nicaraguan Indigenous communities of Li Auhbra and Li Lamni living along the Wangki River (also known as the Rio Coco), which is also polluted by mercury from gold mining, had elevated levels of total mercury in their hair with a mean of 1.54 ppm ± 0.85 ppm (fw), on average more than 1.5 times above the current potential fetal harm level. Of these participants, levels of mercury in 40 women (80%) exceeded the current threshold level of 1 ppm, and in 49 women (98%) exceeded the more health-protective proposed level of 0.58 ppm. The highest mercury concentration recorded was more than four times higher than the current potential fetal harm level (4.64 ppm in Li Lamni).
- In both Peru and Nicaragua, gold extraction using mercury continues, and historical and contemporary mining sites continue to contribute mercury contamination to the aquatic food chain. Gold mining using mercury in Peru is ongoing even though the country has banned mercury imports and launched military operations against illegal gold mining.
- Weaknesses in the Minamata Convention on Mercury continue to allow the global trade in mercury and its diversion to ASGM despite national prohibitions on the practice in some countries.
- Amendments to the convention which dramatically reduce global supply are necessary to restrict legal and illegal shipments of mercury destined for ASGM.
- Mercury-specific medical diagnosis and treatment is immediately required in all locations where sampling was conducted for this study. The situation in the Indigenous communities of Peru who engaged in this study is especially urgent given the very high body burden of mercury observed.
- The human rights of Indigenous communities in active ASGM locations are being compromised and undermined by the use of mercury in ASGM and its consequent negative impacts on their health and wellbeing, food supply, and cultural aspects of land management.

CONTENTS

EXECUTIVE SUMMARY

This study builds upon the IPEN and BRI global mercury sampling program that began in 2010 with sampling hair of delegates for mercury at the first International Negotiating Committee (INC) of what was to be the Minamata Convention on Mercury. Since then, our biomonitoring has extended across the world with participants from more than 30 countries. Women of childbearing age in all these countries (defined as 18-44 years for this project) volunteered to provide hair samples for analysis of the total mercury (THg) content, which allows for comparison to established body burden thresholds to determine if they are within 'safe' levels.

The current study was conducted in Peru and Nicaragua exclusively within Indigenous communities. This was intended to build upon our 2021 study[1] of women from four Latin American countries (Bolivia, Venezuela, Colombia, and Brazil) where artisanal and small-scale gold mining (ASGM) is conducted using mercury (with the exception of Colombia, where mercury gold processing is prohibited). In that study, we observed high levels of mercury among Indigenous populations in Bolivia who were heavily reliant on fish from their local river system, in comparison to established thresholds for THg concentrations in hair. Notably, women from two communities on the same river but located more than 300 km apart had similar, highly elevated mercury levels, inferred to result from regular consumption of mercury contaminated fish. As early as 1999, studies (Maurice-Bourgoin et al., 1999) identified dangerously high levels of mercury contamination in Beni River predatory fish. The fish had become contaminated due to mercury releases from small-scale gold mining into the river. More recent assessments confirm ongoing mercury contamination of fish of the Beni River (Rodriguez-Levy et al., 2022). This demonstrates that it is likely that hundreds of kilometers of the river system are compromised by mercury contamination impacting the aquatic food chain.

In this study, we hypothesized that similar impacts may be occurring to Indigenous populations in other countries in areas linked by river systems and largely dependent on fish and other aquatic life for their dietary protein. Based on advice from IPEN Participating Organizations and Indigenous representative organizations on the ground, we chose locations in Peru and Nicaragua. In Peru, in 2016, 11 districts of the Madre de Dios region were declared by Supreme Decree No. 034-2016-PCM[2] to be in a public health emergency due to high levels of mercury detected in human populations. Based on these concerns and advice from local Indigenous organizations, we conducted sampling in four indigenous communities along the Madre de Dios River system. In Nicaragua, we conducted sampling in the Li Lamni and Li Auhbra communities situated along the banks of the Rio Wangki (also known as Rio Coco), which forms the border between Honduras and Nicaragua and is home to many Indigenous communities.

The results demonstrate that, for Peru in particular, dietary consumption of fish and other aquatic life with elevated mercury concentration harvested from the river is leading to an increased dietary mercury exposure for these Indigenous communities. Other Indigenous communities reliant on fish from these rivers may be similarly exposed to mercury, and this should be investigated. While the results from Nicaraguan communities were not, on average, as high as the results from Peru, they were still very concerning, with 80% of participants exceeding the reference level of 1 ppm and 4% exceeding 4 ppm. A similar pattern emerged with both Nicaraguan communities reporting very similar average levels of contamination.

Dietary surveys indicate that a difference in the types of seafood consumed in Peru versus Nicaragua may contribute to the participants' varying mercury levels.

The hair sampling was conducted in identical fashion at all four sites by NGOs using a verified and approved methodology and a science-based protocol to ensure comparability of results and minimization of cross-contamination. The hair samples were shipped to the Biodiversity Research Institute (BRI) in the USA for laboratory analysis, and the mercury concentrations of the samples are reported in parts per million (ppm) for comparison against the US EPA reference threshold level of 1 ppm[3] (the 'current' level). The methodology, analysis, and comparison to reference levels are described in section 2.

1 https://ipen.org/documents/mercury-exposure-women-four-latin-american-gold-mining-countries

2 https://www.actualidadambiental.pe/wp-content/uploads/2016/05/Decreto-Supremo-034-2016-PCM.pdf

3 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.

Artisanal and small-scale gold mining (ASGM) activity using mercury is currently the leading source of global mercury pollution, accounting for 38% of global anthropogenic emissions. ASGM released about 1,220 tons of mercury into terrestrial and freshwater environments in 2015.[4] In some locations in countries of Latin America, there is limited data available about the impact of mercury use on the environment, ecosystems, and the people who live there. Women of childbearing age are considered a particularly sensitive sub-group as, should they become pregnant, the fetus is especially susceptible to the developmental impacts of mercury, which acts as a powerful neurotoxin that can harm the developing brain. The study results demonstrate that Indigenous women reliant on fish for protein living along rivers in proximity to gold mining activity using mercury have elevated mercury levels. Analysis of the questionnaires provided by the participating women suggests that dietary exposure through contaminated fish is the primary source of elevated mercury levels in women.

The Minamata Convention on Mercury still allows the global legal trade in mercury to continue and does not prohibit the use of mercury in ASGM. Until the Convention is amended to address these issues, the trade in mercury for ASGM will continue, and the impact on the environment and human health will continue to grow.

4 UNEP. 2019. Global Mercury Assessment 2018. UN Environment Programme. Chemicals and Health Branch. Geneva, Switzerland.

Hair sampling team from FENAMAD near a sampling location on the Madre de Dios River

1. INTRODUCTION

The Minamata Convention on Mercury (the Mercury Treaty) was adopted in October 2013 and entered into force on August 16, 2017, giving it the power of binding international law for those Parties that have ratified it. The creation of the Mercury Treaty serves to remind us that the global community now recognizes mercury pollution as a global threat to human rights, human health, livelihoods, and the environment, and are now prepared to commit to further action to reduce global exposure to mercury. IPEN contributed to the negotiations from their inception through adoption of the Minamata Convention and continues to seek to strengthen its provisions and provide support and information to Treaty delegates to inform them of the wide range and severity of mercury pollution issues faced globally as well as potential solutions.

Since the Mercury Treaty entered into force, IPEN has continued to contribute to the ongoing Treaty negotiations, particularly around technical matters related to implementation of the Treaty and in the gathering of data to support mercury-reduction activities. IPEN continues to conduct a range of Mercury Treaty-related enabling activities, to release publications with original research on mercury and threats to health and the environment, and to develop awareness-raising campaigns that include mercury monitoring and biomonitoring. Parties to the Treaty recognize that specific data is required to establish baselines of global mercury contamination levels so that the effectiveness of the Treaty measures may be assessed over time. Biomonitoring activities are crucial to fill the data gaps on potential mercury impacts, particularly in developing countries and countries with economies in transition.

This study is the latest in a series of mercury exposure studies of women of childbearing age conducted jointly by IPEN and BRI. It was undertaken to generate mercury biomonitoring data in locations where significant data gaps exist on women's exposure to mercury and where sources of mercury pollution are suspected. Specifically, these are regions in Latin American countries where small-scale gold mining is conducted using mercury.

In this study, 105 women of childbearing age from six Indigenous communities in Nicaragua and Peru volunteered to provide hair samples for analysis of total mercury concentration. All the communities where sampling took place are heavily reliant on fish from local rivers for dietary protein. The same rivers are subject to ASGM mining either via barges on the river, operations on the riverbanks, or are subject to mercury-contaminated run-off from ASGM tailings further inland.

Previous studies by IPEN and BRI have found that women living in locations or regions where ASGM is conducted often have an elevated body burden of mercury through either handling mercury, living in proximity to mercury extraction of gold, and/or eating contaminated fish from lakes and rivers contaminated with mercury from gold processing.

In recent years, it has been observed that Indigenous populations in regions where mercury is used in gold processing have been subject to a range of human rights violations directly related to small-scale gold mining activity, including contamination of food sources. A recent report[5] by Professor Marcos Orellana, the UN Special Rapporteur on Human Rights and Toxics, identified the use of mercury in gold extraction in Latin America as a hotspot for human rights abuses against Indigenous Peoples and recommended changes to the Minamata Convention to address this issue. ***In particular, Professor Orellana recommended amending the Convention to end the global trade in mercury and establishing a phase-out date for the use of mercury in gold mining.***

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5 Orellana, M. (2023) A/HRC/51/35: Mercury, small-scale gold mining and human rights – Report of the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes. https://docs.un.org/en/A/HRC/51/35

1.1 BIOMONITORING

Mercury biomonitoring is an important element of any strategy to assess, monitor, and reduce global mercury pollution, while highlighting local hotspots that may require urgent attention if exposure levels are high. Global data on mercury biomonitoring has been fragmented with many data gaps, especially from developing countries and countries with economies in transition. In response to the need for better data, IPEN has developed an important collaboration with the Biodiversity Research Institute (BRI), a non-profit, ecological research group with more than 25 years of experience assessing emerging threats to wildlife and ecosystems.

BRI is a world leader in ecological research related to mercury monitoring and toxicology and provides expertise and advice to many parties to the Mercury Treaty. This study adds to the long list of locations across the globe where IPEN and BRI have collaborated using their technical expertise and broad reach through a global network of IPEN Participating Organizations (POs). Previous joint projects have included mercury monitoring in women of childbearing age in the Asia and Pacific region, Small Island Developing States, Eastern Europe, Africa, Latin America, and many other locations. This study builds upon previous sampling activity in Latin America in 2021[6] with a specific focus on Indigenous communities.

The sample results for this study will be added to the database of hundreds of previous samples analyzed by BRI at their laboratory in Maine, USA. These samples were provided voluntarily by women concerned about their mercury body burden and potential future impacts on their unborn children. Mercury is a potent neurotoxin to which the fetus is highly susceptible, and providing women of childbearing age with data on their mercury body burden empowers them to make informed decisions on reducing their exposure to mercury in order to better protect their health.

Hair samples in Latin America were collected by IPEN Participating Organizations and other civil society organizations in cooperation with local communities. This form of mercury monitoring can act as an impetus for countries to ratify and implement the Mercury Treaty and reduce mercury pollution while establishing a baseline to observe any future reductions in mercury among their populations that follow from reduction measures.

Parties to the Mercury Treaty have agreed that there is a need to generate mercury monitoring data from around the globe that can be used to evaluate the effectiveness of the Treaty in reducing mercury pollution over time. Currently, the process for effectiveness evaluation is being conducted by an expert committee of the Treaty, and data from this report may contribute to their work.

In 2014, IPEN launched the International Mercury Treaty Enabling Activities Program (IMEAP) with the aim of supporting preparations for developing countries and countries with economies in transition for rapid ratification and early implementation of the Mercury Treaty. IPEN successfully completed mercury-related research projects and associated activities in 29 countries via IMEAP.

Through this process, member organizations communicated to IPEN the need to conduct targeted mercury biomonitoring to address widespread data gaps, to further elevate mercury awareness, and to promote ratification of the Mercury Treaty. Since then, several Indigenous organizations from Latin America have become IPEN Participating Organizations and have expressed the urgent need for biomonitoring among Indigenous populations who are dependent on local food sources that may be contaminated by mercury use in gold mining.

In 2015, IPEN developed a mercury biomonitoring program focusing on vulnerable sub-populations identified in the Mercury Treaty preamble, as well as in Article 16 (Health aspects), Article 18 (Public information, awareness and education), Article 19 (Research, development and monitoring), Article 22 (Effectiveness evaluation), Annex C – Artisanal and small-scale gold mining (ASGM), and National Action Plans (NAPs) of the Treaty. In many developing and transition countries, there is a paucity of mercury biomonitoring data with which to inform policy decisions and generate public awareness about the hazards of mercury exposure.

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6 Bell, L., Evers, D., Burton, M. (2021) Mercury Exposure of Women in Four Latin American Gold Mining Countries: Elevated Mercury Levels Found Among Women where Mercury Is Used in Gold Mining and Contaminates the Food Chain. IPEN June 2021, Berkeley California.

IPEN, through its earlier mercury biomonitoring project collaborations[7] with BRI, gained valuable insights into potential locations for monitoring while building capacity within its network to implement a broader range of monitoring activities. IPEN determined that there was a need to generate data from around the globe, with emphasis on small-scale mining activity in Latin America, which has been the destination for much of the mercury traded globally in recent years.

1.2 EXPANDING IPEN'S HAIR MONITORING PROGRAM

In a 2015/16 study[8] (published in 2017), IPEN and BRI partnered with UN Environment (now called UNEP) to conduct mercury biomonitoring of women of childbearing age. Sampling was conducted in four Pacific Small Island Developing States (SIDS) and two non-Pacific countries. Data from that report for the countries of Cook Islands, Marshall Islands, Kiribati, and Tuvalu were later combined with a much larger 2018 IPEN SIDS sampling report,[9] as they used identical methodologies and sampling protocols, to provide a more complete picture of the Pacific SIDS situation and for comparison with non-Pacific SIDS.

In the subsequent IPEN/BRI global study, "Mercury in Women of Child-bearing Age in 25 Countries," the Solomon Islands, Tonga, Vanuatu, Samoa, and Fiji were added to the sampling database. The mercury monitoring results from the 2015/16 study and subsequent global study showed elevated mercury levels for nearly all participants from Pacific Islands. Given the lack of local pollution sources, this could be attributed to mercury contamination of fish, which is a key component of islanders' diets and the predominant protein source for hundreds of thousands of Pacific Islanders. The main finding of the collaborative study between IPEN, BRI, and UN Environment was that the Pacific Islanders we studied face a serious problem from mercury contamination of fish, which comprises a major part of their diet. The problem may have significant ramifications for all Pacific Islanders, as nearly all of those assessed exceeded the 1 ppm threshold level for mercury contamination of their hair. The elevated results across most SIDS, where fish is a dietary staple, suggest a widespread contamination issue which may be having population-level effects that require additional monitoring and reduction measures.

The results of the global and Small Island Developing State studies clearly demonstrated that a fish-rich diet (and in some cases, diets including sea mammals such as seals) is a direct exposure pathway for mercury to enter the human body and raise the mercury body burden. However, while a fish-rich diet contributes significantly to the mercury body burden, it is not the only form of exposure that can result in an elevated mercury body burden.

Artisanal and small-scale gold mining is the primary source of mercury releases to the atmosphere, land, and water in the world today, contributing 38% of global mercury emissions compared to coal-fired power which contributes 22%.[10] IPEN biomonitoring in ASGM communities in Southeast Asia and Africa recorded some of the highest body burdens of mercury among any of the women of childbearing age in our monitoring program to date.

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7 Evers, D. et al. (2014). Global mercury hotspots: New evidence reveals mercury contamination regularly exceeds health advisory levels in humans and fish worldwide. Biodiversity Research Institute. Portland, Maine. IPEN. Göteborg, Sweden. BRI-IPEN Science Communications Series 2014-34. 2 pages.

8 Bell, L., et al. (2017) Mercury Monitoring in Women of Child-Bearing Age in the Asia and the Pacific Region. A joint study by UN Environment, Biodiversity Research Institute and IPEN. April 2017. Berkeley, California.

9 Bell, L., et al. (2018) Mercury Threat to Women and Children Across 3 Oceans. Elevated Mercury in Women in Small Island States and Countries. A joint study by Biodiversity Research Institute and IPEN. April 2017. Berkeley, California.

10 UN Environment (2019) Global mercury Assessment 2018. UN Environment Programme. Chemicals and Health Branch, Geneva. Switzerland.

Reports of expanding ASGM activity in Latin America, increased trade in mercury supply to the region, and requests from NGOs on the ground for up-to-date biomonitoring data among Indigenous Peoples led IPEN and BRI to initiate pilot sampling studies in ASGM-related locations in Bolivia, Brazil, Colombia, and Venezuela.[11] The consistent and very high levels of mercury recorded among related Indigenous communities in Bolivia, living beside the same river but separated by over 300 kilometers, provided a strong indication of widespread mercury contamination through the food chain. Both communities relied heavily on fish caught in the River Beni for their dietary protein. The current study considers mercury impacts on several Indigenous communities reliant on fish from the Madre de Dios River in Peru and the tributaries of the Wangki River (Rio Coco) in Nicaragua. More countries in the region may be included in future studies.

1.3 HEALTH IMPACTS OF MERCURY EXPOSURE FROM ASGM

Mercury is a potent neurotoxin to humans and can affect the central nervous system of the developing fetus months after the mother's exposure. The harmful effects that can be passed from the mother to the fetus include neurological impairment, IQ loss, and damage to the kidneys and the cardiovascular system. Symptoms of intoxication include tremors, insomnia, memory loss, neuromuscular effects, headaches, and cognitive and motor dysfunction. High levels of mercury exposure can lead to brain damage, intellectual disability, blindness, seizures, and the inability to speak.[12] According to the US EPA, the threshold for impacts is 1 ppm, and recent studies have proposed a more health-protective standard of 0.58 ppm. The predominant exposure pathway for mercury impacting the health of ASGM workers is mercury vapor inhalation which can lead to a condition called chronic metallic mercury vapor intoxication (CMMVI). Workers' health can also be impacted by eating local food sources contaminated by mercury such as fish and rice.[13] Women are often employed in ASGM activities and in some locations are more exposed to mercury than men, as the men are engaged in the extraction of ore while women may process the ore with mercury.

Even if women are not engaged in ASGM, they may have family members who are, or they may live next to ball mills, amalgam burning activity, or simply eat the local fish and rice contaminated by ASGM activity. In this study the focus is on mercury exposure for women eating fish from rivers contaminated by ASGM mercury releases. Due to the sensitivity of the fetus to the neurotoxic impacts of mercury, IPEN takes hair samples from volunteers who are women of childbearing age and who may be considering having children. As a sensitive sub-group of the local population, the mercury body burden of women in this cohort is an important indicator as to the potential effects of mercury on the local communities near the gold mining sites.

1.4 ECONOMIC IMPACTS OF MERCURY BODY BURDEN

While the health impacts of elevated mercury levels in the human body are well documented, a ground-breaking study[14] by Trasande et al. has also estimated the economic losses attributable to lost productivity in those populations where levels of mercury body burden exceed 1 ppm. The study analyzed hair samples from 15 developing countries and countries in economic transition. The results showed that 61% of all participants had hair mercury concentrations greater than 1 ppm. Using a linear dose-response relationship and an assumed 0.18 IQ point decrement per parts per million (ppm) increase in hair mercury concentrations, an estimate of lost productivity was developed. This data was used to estimate increases in intellectual disability and lost Disability-Adjusted Life Years (DALY).[15] A total of USD $77.4 million in lost economic productivity was estimated, assuming a 1 ppm reference level, and USD $130 million if no reference level was used.

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11 Bell, L., Evers, D., Burton, M. (2021) Mercury Exposure of Women in Four Latin American Gold Mining Countries: Elevated Mercury Levels Found Among Women where Mercury Is Used in Gold Mining and Contaminates the Food Chain. IPEN June 2021, Berkeley California.

12 Grandjean, P., Weihe, P., White, R. F., Debes, F., Araki, S., Yokoyama, K., ... & Jørgensen, P. J. (1997). Cognitive deficit in 7-year-old children with prenatal exposure to methylmercury. Neurotoxicology and teratology, 19(6), 417-428.

13 Feng, X., Li, P., Qiu, G., Wang, S., Li, G., Shang, L., ... & Fu, X. (2008). Human exposure to methylmercury through rice intake in mercury mining areas, Guizhou Province, China. Environmental science & technology, 42(1), 326-332.

14 Trasande L, DiGangi J, Evers D, Petrlik J, Buck D, Samanek J, Beeler B, Turnquist MA, Regan K (2016) Economic implications of mercury exposure in the context of the global mercury treaty: hair mercury levels and estimated lost economic productivity in selected developing countries, Journal of Environmental Management 183:229 - 235, doi: 10.1016/j.jenvman.2016.08.058 https://www.ncbi.nlm.nih.gov/pubmed/27594689

15 DALY is a measurement of years of life lost due to premature death, plus years lost to severe disability.

The Trasande et al. study points to far-reaching economic impacts from mercury pollution that will be borne by those countries least able to address the source of the mercury pollution and least able to bear such costs. Therefore, it is important to consider the whole scope of mercury pollution impacts in terms of human health, economic burden, and ecological integrity. It has also been estimated (Steckling et al. 2017) that on a global scale, 3.3-6.5 million miners suffer from moderate CMMVI. The burden of this disease in terms of DALYs is estimated to range from 1.22 to 2.39 million DALYs. This makes mercury intoxication a major global public health problem and economic burden.

1.5 THE MINAMATA CONVENTION MUST BE AMENDED TO BAN MERCURY USE IN ASGM

The Minamata Convention was negotiated over several years between many Parties and as such represents a product of compromise negotiations. This has led to a number of weaknesses in the Convention that hamper its ability to rapidly reduce global mercury pollution. Three major weaknesses combine to allow the trade in mercury for use in ASGM to continue unabated.

1. Mercury is permitted to be traded on the international commodity market for a 'use allowed' under Article 3 of the Convention. Allowed uses include dental amalgam, laboratory research, and certain other products and processes requiring the use of mercury where alternatives are not available. Some of these processes, such as chlor-alkali plants (phase-out date 2025), acetaldehyde production (phase-out date 2028), and vinyl chloride monomer plants use large quantities of mercury, but most can be sourced domestically. As of 2025, most products and industrial processes using mercury have been phased out. However, Parties can extend the phase-out dates by five years by exemption, with an option for an additional five years. This effectively allows large flows of mercury to be legally traded internationally for another decade and extends a very difficult task for customs officers of identifying any illegal shipments of mercury intended for ASGM use, as shipments are often falsely labelled as being intended for an 'allowed use,' such as dental amalgam, but are diverted to ASGM.
2. Primary mining of mercury from cinnabar mines is permitted under Article 5 for up to 15 years from the date of entry into force of the Convention for a Party. New mines cannot be opened, but existing mines can continue to operate for this period (and possibly extended via exemption). This allows new primary supplies of mercury to be traded on the international commodity market. Although mercury from this source is only permitted to be used in the manufacture of mercury-added products in accordance with Article 4 of the Convention and in manufacturing processes listed in Article 5 of the Convention, shipments can be labelled for a false end use and redirected to ASGM. Primary mercury mining is prohibited by the Treaty after 2032.
3. Use of mercury is 'allowed' for ASGM, although each country with significant ASGM activity must develop a National Action Plan (NAP) to reduce mercury use in this sector. While many countries may domestically make mercury use in ASGM illegal, the Convention does not. There is no phase-out date in the Convention for the use of mercury in ASGM, thereby allowing indefinite use of mercury in this sector unless individual national governments prohibit its use.

These loopholes act as signals at the international level that mercury use in ASGM is to be tolerated. It has been argued that such use is needed to provide a livelihood for the millions of people engaged in this activity; however, it is contrary to the human rights of workers and communities impacted by mining to tolerate unhealthy conditions on economic grounds – especially if the impacts also affect parts of the population, that is, the millions globally who eat mercury contaminated fish and food who do not benefit from gold extraction. If the international trade in mercury was prohibited and mercury use in ASGM was subject to a phase-out date by the Convention, then Parties to the Convention could take stronger action on the ground to enforce the ban and protect their citizens' human rights.

2. METHODOLOGY

In preparation for the implementation of this project, IPEN and BRI adapted the methodology based on the framework for hair sampling previously developed by IPEN, BRI, and UNEP in a 2016 mercury biomonitoring project for the Asia and the Pacific Regions,[16] for a much larger 2017 IPEN/BRI global hair monitoring study,[17] and for a recent IPEN/BRI study in ASGM regions in Latin America.[18] The methodology takes into account scientifically sound and acknowledged human hair monitoring protocols, including both technical and practical matters as well as an ethics review by the Institutional Review Board of the University of Southern Maine in Portland, USA. The methodology covers sampling method, collection of data, mercury measurements, sample storage and shipping, as well as assessment and evaluation of the results and feedback to participants.

The results of the 2021 study in several Latin American artisanal gold mining regions revealed a concerning trend affecting Indigenous Bolivian women who are almost entirely reliant on freshwater fish for dietary protein. The Eyiyo Quibo and the Portachuelo communities are two related Indigenous communities situated around 380 kms apart on the banks of the Beni River in Bolivia. The area is impacted by mercury contamination arising from ASGM activity. Dietary surveys indicated that the women were heavily reliant on fish from the river and consumed them almost daily. The mercury body burden results of the participants were significantly elevated with an average of 7.58 ppm total mercury measured in hair, and over 93% of the women exceeding the 1 ppm threshold level.[19] These results indicate that large parts of the ecosystem of the Beni River are contaminated for hundreds of kilometers. This finding supports earlier studies indicating significant fish contamination by mercury from ASGM in the Beni River (Maurice-Bourgoin et al., 1999). In turn, Indigenous communities are being impacted due to mercury contamination of their traditional foods.

Taking these indicators into account, IPEN and BRI have developed the sampling methodology for this study to maintain consistency with previous studies and allow data comparison while also focusing on Indigenous communities in ASGM regions connected by freshwater river systems. This approach was chosen to further investigate the impact of mercury from ASGM on Indigenous Peoples in connected freshwater systems where fish are a staple of their diets.

2.1 SAMPLING METHOD

2.1.1 TARGET GROUP

The focus of this project is the vulnerable sub-population group of women of childbearing age in Latin American communities impacted by ASGM activities. In this study, Indigenous communities in Nicaragua and Peru were selected to assess impacts from mercury related to their fish diets. The definition of 'childbearing age' differs to some degree between various institutions. Studies undertaken by United States researchers use the age range of 18-44 years due to US federal government limitations on sampling of biological material from minors. For this project, the target group for sampling is women of childbearing age from 18-44 years, as it would allow comparison with other studies using this range while meeting legal requirements of the BRI laboratory based in the US. The gender-specific impacts of toxic pollutants on women are increasingly being recognized as a global priority for investigation and redress. IPEN and UN Environment announced the establishment of a partnership[20] on the issue of chemical impacts on women at the 3rd United Nations Environment Assembly in Nairobi, Kenya. This study seeks to further the information on the impacts of mercury on Indigenous women in Latin America.

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16 Bell, L. , et al., (2017) Mercury Monitoring in Women of Child-Bearing Age in the Asia and the Pacific Region. A joint study by UN Environment, Biodiversity Research Institute and IPEN. April 2017. Berkeley, California.

17 Bell, L., et al. (2017) Mercury in Women of Child-bearing Age in 25 Countries. A joint study Biodiversity Research Institute and IPEN. November 2017. Berkeley, California.

18 Bell, L., et al. (2021) Mercury exposure of women in Four Latin American gold mining countries. A joint study by Biodiversity Research Institute and IPEN. June 2021. Berkeley, California.

19 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.

20 The full statement regarding the partnership on women and chemicals is available at https://ipen. org/documents/statement-partnership-between-ipen-and-unep-focus-women-and-chemicals

2.1.2 PARTICIPANT SELECTION

Female participants were selected based on the criteria of (1) their age (18 - 44 years); (2) willingness to participate; and (3) having sufficient hair to provide a sample for analysis. IPEN Participating Organizations (POs) and non-affiliated civil society organizations (CSOs) identified and convened participants at each location to administer the consent forms and questionnaires and conduct hair sampling according to the specified protocols. The POs and CSOs gathered samples in a scientifically sound manner that is consistent with recognized standards for sample collection of human hair for mercury monitoring.[21] All were issued the standardized methodology and protocols developed by BRI and IPEN to ensure consistency and comparability between this study and previous hair mercury monitoring studies conducted by IPEN and BRI. Locations where sampling took place were selected based on advice from local POs and CSOs which considered issues of access, cultural sensitivities, timing, and cooperative approaches with local communities and civil society organizations that supported the sampling.

2.1.3 ETHICS REVIEW AND CONFIDENTIALITY OF PARTICIPANTS

Prior to implementing this sampling project, the overall methodology was reviewed and approved by the Institutional Review Board of the University of Southern Maine in the USA to ensure it met contemporary standards for ethical implementation of studies involving human subjects. The sample collection protocol incorporated documents and procedures consistent with this ethics approval. Participants were asked to sign a consent form if they were willing to have a hair sample collected for analysis. A questionnaire was then administered to the participants by the IPEN PO or CSO representative supported by a local, native language-speaking volunteer to ensure that the process was understood by the participants and that accurate information could be collected from the questionnaires. Where English was not an appropriate language, participants were provided with a translation of relevant documentation, including waivers, questionnaires, and sample results. The right of confidentiality was granted to each individual participant unless she voluntarily decided to sign a document to waive confidentiality.

To protect confidentiality of participants, several controls were implemented. Project-related data is presented as an aggregated analysis that does not enable public identification of individual participants. Each hair sample shipped to the BRI laboratories was labelled with an individual sample ID code and country location code so that BRI did not have access to the identities of individual sampling participants. The same ID code is affixed to the front page of each completed questionnaire, allowing the data from questionnaires to inform the interpretation of sample analysis by IPEN without compromising confidentiality. The PO or CSO that conducted the sampling holds the master list linking the ID code to the name of the participant to allow them to provide contextual, health-related feedback to the individual participant along with the results of their individual hair sample analysis with total mercury concentrations. Once individual participant sample data is generated and communicated back to the participant, that individual has the right to release that information and publicly identify herself if she chooses to do so. This is consistent with an individual's right to know about their personal health information and disclose it if they wish.

2.1.4 SAMPLE COLLECTION PROTOCOL

All POs and CSOs tasked with coordinating the collection of samples were provided with detailed sample collection, packaging, and shipping protocols to ensure minimization of any cross-contamination and to standardize sample collection for comparative analysis. Before taking any samples, the participant was invited to sign the consent form. If the participant declined, no sample was taken. After the participant signed the consent form, the sampler then administered the questionnaire. Following the completion of documentation, the sampler, while wearing a pair of nitrile examination gloves (for collecting and handling each sample), would use an alcohol wipe to clean the cutting surfaces of the stainless-steel scissors for cutting the hair sample. Hair samples were obtained from individuals by cutting a small bundle of hair approximately 8 - 10 cm long and the thickness of a pencil (about 30 hair strands) from the occipital region of the skull as close as possible to the scalp. The hair sample was then secured with a small self-adhesive label using an arrow to indicate the direction of the scalp and leaving 3 - 4 cm of hair exposed from the label.

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21 United Nations Environment Programme and the World Health Organization (UNEP/WHO), (2008) Guidance for identifying populations at risk from mercury exposure.

2.1.5 SAMPLE ANALYSIS – MERCURY MEASUREMENT

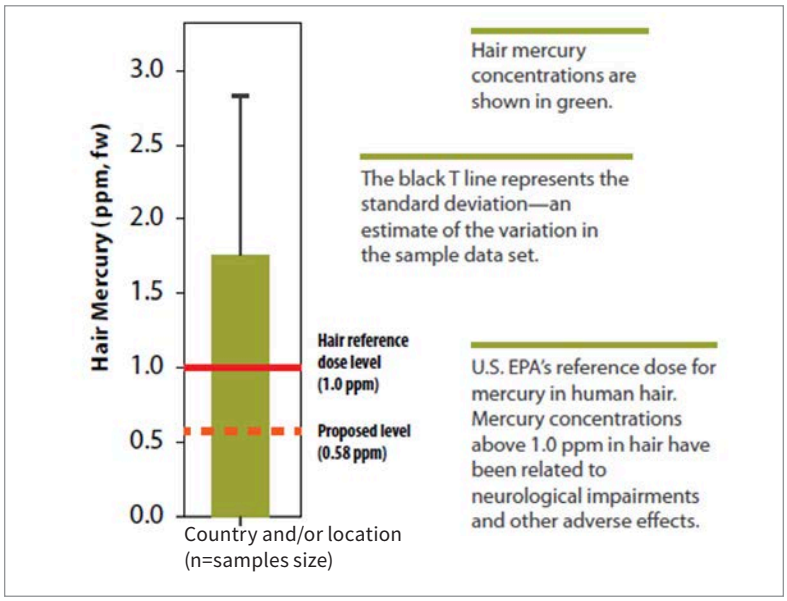
Once correctly packaged and labelled, the samples were shipped by courier along with a data sheet listing each sample origin and a corresponding sample ID code. As soon as shipments arrived in the USA, the hair samples were analyzed for total mercury at BRI's Toxicology Laboratory following EPA method 7473 by gold-amalgamation atomic absorption spectroscopy following thermal desorption of the sample using a Milestone DMA-80 or a Nippon MA-3000 (beginning in 2021). For each run, two blanks and a blank boat followed by two calibration standards (DORM-3 and DOLT-4 or DOLT-5 and IAEA-436a) targeting the two detector cells were used to check instrument performance. Instrument response is evaluated immediately following calibration, and thereafter, a certified reference material targeting both the high and low cell is run every 10 samples. Each analytical run ended with a check blank and two certified reference materials. Instrument detection limit is approximately 0.001 ng. Results of total mercury are then recorded for each sample in parts per million (ppm) and recorded in tables by location.

2.1.6. ASSESSMENT OF RESULTS

The interpretation of sample results was based on the comparison of data generated from the field samples with a reference level of 1 ppm (parts per million), which equates approximately to the US EPA's reference dose for mercury in human hair.[22] Mercury concentrations above 1 ppm in hair have been related to neurological impairments in adults.[23,24] These data will help determine contaminant concentrations in participating human subjects and potentially identify regions that require more intensive investigation.

In addition, recent advances in the study of mercury impacts on the developing fetus suggest that levels of mercury body burden for women of childbearing age above 0.58 ppm as measured in hair concentrations of total mercury (THg) may have subtle but problematic impacts on the cognitive development of the developing fetuses of pregnant women.[25] For this reason, IPEN has applied the additional 'proposed' level of 0.58 ppm against the reported sampling results to assess relative levels of the groups studied. A number of scientists with expertise in this field have proposed that the US EPA threshold level of 1 ppm should be updated to the more health-protective 0.58 ppm level. The data is presented in a similar manner to the example in Figure 1 showing both the 1 ppm and 0.58 ppm levels as a solid and dashed line, respectively, against the sampling results.

Figure 1 Interpretation of the mercury hair concentration chart.

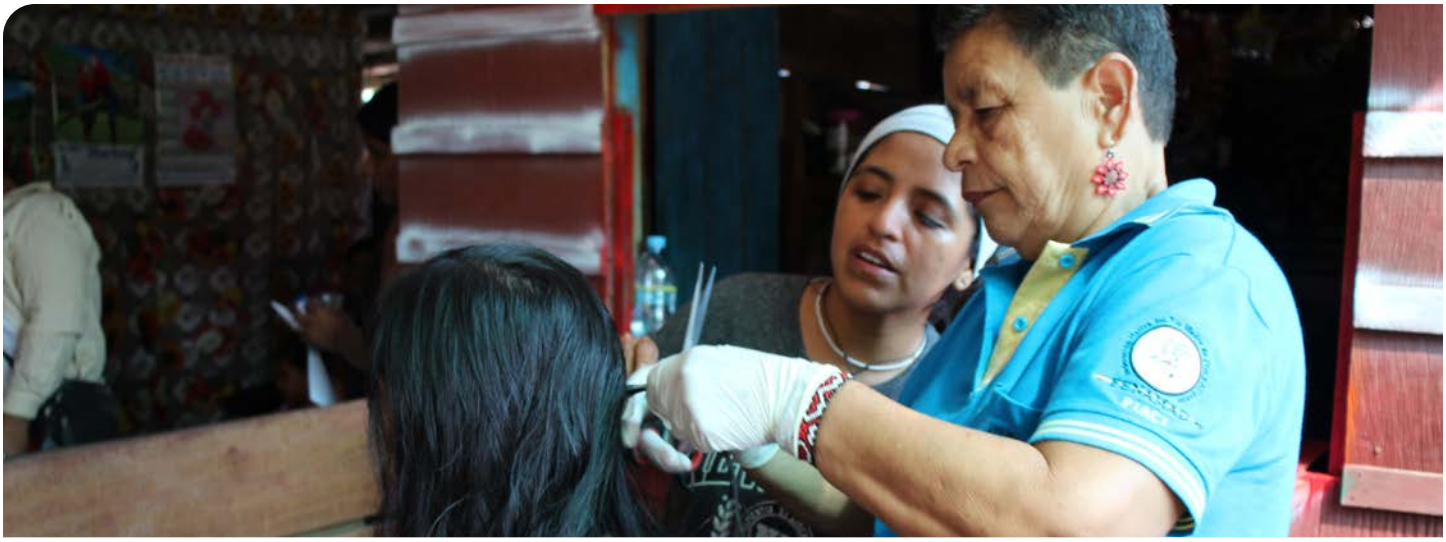


22 US EPA (1997) Mercury study report to Congress, Volume IV, An assessment of exposure to mercury in the United States. EPA-452/R-97-006

23 Yokoo, E.M., Valente, J.G., Grattan, L., Schmidt, S.L., Platt, I. and Silbergeld E.K. (2003) Low level methylmercury exposure affects neuropsychological function in adults. Environmental Health 2(1):8.

24 Karagas, M., Choi, A.L., Oken, E., Horvart, M., Schoeny, R., Kamai, E., Grandjean, P., and Korrick, S. (2012) Evidence on the human health effects of low-level methylmercury exposure. Environmental Health Perspectives, 120: 799-806

25 Grandjean P, Pichery C, Bellanger M, Budtz-Jørgensen E (2012) Calculation of Mercury's effect on Neurodevelopment. Environ Health Perspect. 2012 December; 120(12).



3. SAMPLING LOCATIONS

3.1 PERU

Hair sampling was conducted by the IPEN Participating Organization (PO) Federación Nativa del Río Madre de Dios y Afluentes (FENAMAD) on behalf of IPEN in several locations where there are communities of Indigenous Peoples who are impacted by mercury from small-scale gold mining operations. The communities chose not to be identified in this report but were all located within the Madre de Dios region close to the main river system. They are hereafter identified as Communities 1-4.

Hair samples were taken from women aged between 18-44 years who voluntarily participated in the project in the following communities between September 20 and October 2, 2023:

1. Community 1
2. Community 2
3. Community 3
4. Community 4

All the communities are situated along the Madre de Dios River in Peru. Artisanal gold mining is conducted both upstream of the communities in the Madre De Dios Territorial Reserve and along the river where they are located.

Map 1 Indigenous community sampling locations along the Madre de Dios River, Peru

All the communities are part of the Native Federation of the Madre de Dios River and Tributaries (FENAMAD) in the Madre de Dios region in Peru. For entry into each of the native communities, prior coordination was conducted by FENAMAD representatives, and letters of introduction were sent to the presidents of each of the communities indicating the objective of the study and the tentative date for the collection of hair samples. In addition, an informative workshop on the threats of mercury to human health was held in each of the communities.


Contaminated tailings waste at abandoned ASGM site near the Madre De Dios River.

The geographic area affected by mercury contamination includes the middle and lower Madre de Dios River basins and several of their tributaries. Mercury contamination comes from alluvial gold mining activity, developed under a range of conditions (legal, informal, and illegal), mostly by small-scale miners with different technologies to recover powdered gold. The Artisanal Gold Council (2017) estimates that approximately 180 tons of mercury are used annually in the extraction of gold in the region.[26] In 2016, 11 districts of the Madre de Dios region were declared by the government's Supreme Decree No. 034-2016-PCM[27] to be in a public health emergency due to high levels of mercury detected in human populations. The demographic sector most affected by the contamination of mercury in the region are the Indigenous Peoples. The scientific data that support this information come from private research programs, as there are no official mechanisms for effective monitoring of the impacts on human health and the environment in the region.[28]

One local community was the subject of an Inter-American Commission on Human Rights[29] resolution indicating the community was at significant risk from both mercury contamination and threats of violence from third parties (miners). The resolution called on the Peruvian Government to:

- provide urgent mercury-related medical intervention and care for the community;
- provide alternate, culturally appropriate food sources;
- protect the community from armed attackers; and
- report on the measures they have taken to support and protect the community.

Similar problems affect other regional Indigenous communities where sampling also took place. All these communities are working toward establishment of Autonomous Territorial Governments (ATGs), which are established by Indigenous Peoples in Peru to reclaim their rightful territories and manage them in ways that ensure forest protection and cultural continuity. At the core of the establishment of an ATG is the development of a Life Plan for Communal Governance to be implemented by the elected leaders of the community. ATGs also aim to resolve internal community conflicts.[30] The following are brief snapshots of the four Peruvian communities.

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26 AGC (2017) Inventory Report for the ASGM sector in Peru (2017) https://www.artisanalgold.org/resources/publications/country-reports

27 https://www.actualidadambiental.pe/wp-content/uploads/2016/05/Decreto-Supremo-034-2016-PCM.pdf

28 https://www.ohchr.org/sites/default/files/2022-05/defensoria-del-pueblo-peru.pdf https://www.ohchr.org/sites/default/files/2022-05/derecho-ambiente-y-recursos-naturales.pdf

29 Inter-American Commission on Human Rights Resolution no. 38/17 https://www.oas.org/es/cidh/decisiones/pdf/2017/38-17MC113-16-PE.pdf

30 https://amazonwatch.org/news/2024/0327-unity-and-resilience-pioneering-indigenous-self-governance-in-the-peruvian-amazon

COMMUNITY 1

Community 1 has a multi-ethnic population of 300 inhabitants belonging to 120 families. The community does not yet have a Life Plan for Communal Governance.

COMMUNITY 2

Community 2 has a multi-ethnic population of 187 inhabitants belonging to 42 families. In the community, about 57% are men and 43% are women. The community is engaged in the following productive activities: Brazil nut harvesting, mining, fishing, fish farming, and agriculture (Data extracted from the Life Plan for the Communal Governance of the Community 2 2023-2025).

AGE GROUP	MEN	WOMEN	TOTAL
Children 0-6 years old	18	13	31
Children 7-14	22	24	46
Young people aged 15-29	26	13	39
Adults 30-59 years old	29	24	53
Over 60 years	12	06	18
Total	107	80	187
%	57.22%	42.78%	100%

Source: Table prepared in the Life Plan for Communal Governance. Community 2 2023-2025.

COMMUNITY 3

Community 3 has a population of 225 people belonging to 72 families. 44% of its population are men and 56% are women. The productive economic activities to which the community is dedicated are timber forest production, Brazil nut harvesting, agriculture, fishing, farming, and fish farming.

AGE GROUP	MEN	WOMEN	TOTAL
Children 0-6 years old	10	12	22
Children 7-13	15	22	37
Young people aged 14-26	30	35	65
Adults 26-59 years old	30	41	71
Over 60 years	14	16	30
Total	99	126	225
%	44%	56%	100%

Source: Table prepared in the Life Plan for Communal Governance. Community 3 2023-2025.

COMMUNITY 4

Community 4 has 200 inhabitants, belonging to 90 families. In the community, 45% are men and 55% are women. The productive economic activities to which the community is dedicated are timber forest production, Brazil nut harvesting, mining, livestock, agriculture, farming, and fish farming. (Data extracted from the Life Plan for the Communal Governance of Community 4 2023-2025).

AGE GROUP	MEN	WOMEN	TOTAL
Children 0-6 years old	20	16	36
Children 7-14 years old	19	21	40
Young people aged 15-29	25	28	53
Adults 30-59 years old	26	27	53
Over 60 years	8	10	28
Total	98	102	200
%	45%	55%	100%

Source: Table prepared in the Life Plan for Communal Governance. Community 4 2023-2025.

3.2 NICARAGUA

The Waspam municipality in Nicaragua is situated just north of the Autonomous Region of the Northern Caribbean Coast and is a wide strip along the Wangki River (Rio Wangki), also known as the Rio Coco, which forms the border between Honduras and northern Nicaragua. Many Indigenous communities are found in this region where small-scale gold mining also takes place. Some Indigenous Peoples also take part in gold mining using mercury. Previous studies have found significant mercury contamination affecting the environment and communities in this region.

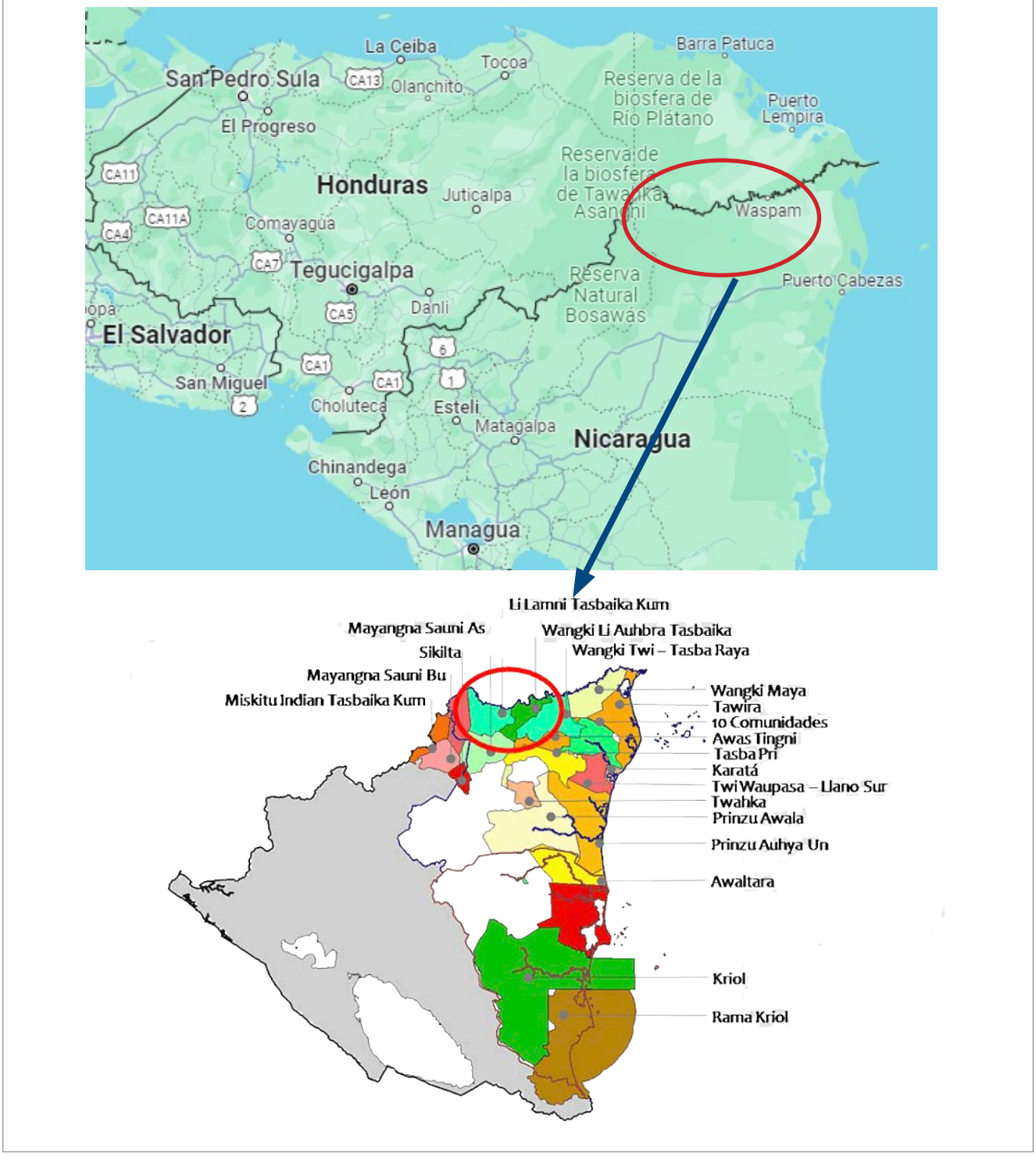
Information provided by local community organizations confirmed that gold panning with mercury takes place mainly in the waters of the Umbra River and the Waspuk River, which are tributaries of the Wangki River. In the Territory of the Li Lamni people, mining is concentrated on the Umbra River in the Cerro Coco Mina and another mining area called Murubila (in Santa Rosa). In the Territory of the Li Auhbra people, on the Waspuk River, mining occurs mainly in areas called Santa Clara and the Mulle. The Waspuk River also forms the border of the Bosawás biosphere reserve. In all these locations, the mining is conducted with mercury causing environmental, social, and cultural impacts.

Two community organizations provided on-the-ground sampling and liaison support with Indigenous communities to assist IPEN in this project.

The Li Auhbra and Li Lamni communities engage mainly in agriculture, fishing, and hunting. A few women from each of the communities who participated in the study self-identified as being 'gold washers,' a job which involves using mercury to extract gold from ore by panning.

Map 2 Map of the Waspam region showing the Rio Umbra and Rio Wasuk tributaries of the Rio Wangki. ASGM using mercury is conducted along both tributaries.

Hair sampling and documentation being carried out by sampling volunteers



Map 3 Territories of the Li Lamni, Li Auhbra and other Indigenous communities below the Rio Wangki

4. RESULTS OF SAMPLING ANALYSIS

The total mercury (THg) concentrations detected in the hair of the participants from both countries where sampling occurred were elevated and were influenced primarily by diet and, in some cases, potential direct exposure to mercury through gold amalgamation. None of the participants from Peru indicated in their surveys that they had any direct role in gold mining. However, 12 participants from Nicaragua indicated that they were involved in 'gold washing', which involves the use of mercury. This subset of the Nicaraguan cohort is discussed in section 5.

Table 1 provides the analytical results for hair sampling, including the average total mercury concentrations for each group, the standard deviation from the mean levels by group, the highest levels recorded by location, and the percentage of the sampled group that exceeded the 1 ppm (unbroken red line) threshold level and the 0.58 ppm proposed level (dashed red line).

Table 1. Results of participant hair analysis for total mercury content in Peru and Nicaragua

LOCATION	NUMBER OF SAMPLES	MEAN MERCURY CONCENTRATION WITH STANDARD DEVIATION (PPM)	NO. OF SAMPLES GREATER THAN 1 PPM	PERCENTAGE OF SAMPLES GREATER THAN 1 PPM	PERCENTAGE OF SAMPLES GREATER THAN 0.58 PPM	HIGHEST LEVEL RECORDED
Peru	55	3.40 ± 2.08	54	98%	100%	9.44 ppm
Nicaragua	50	1.54 ± 0.85	40	80%	98%	4.64 ppm

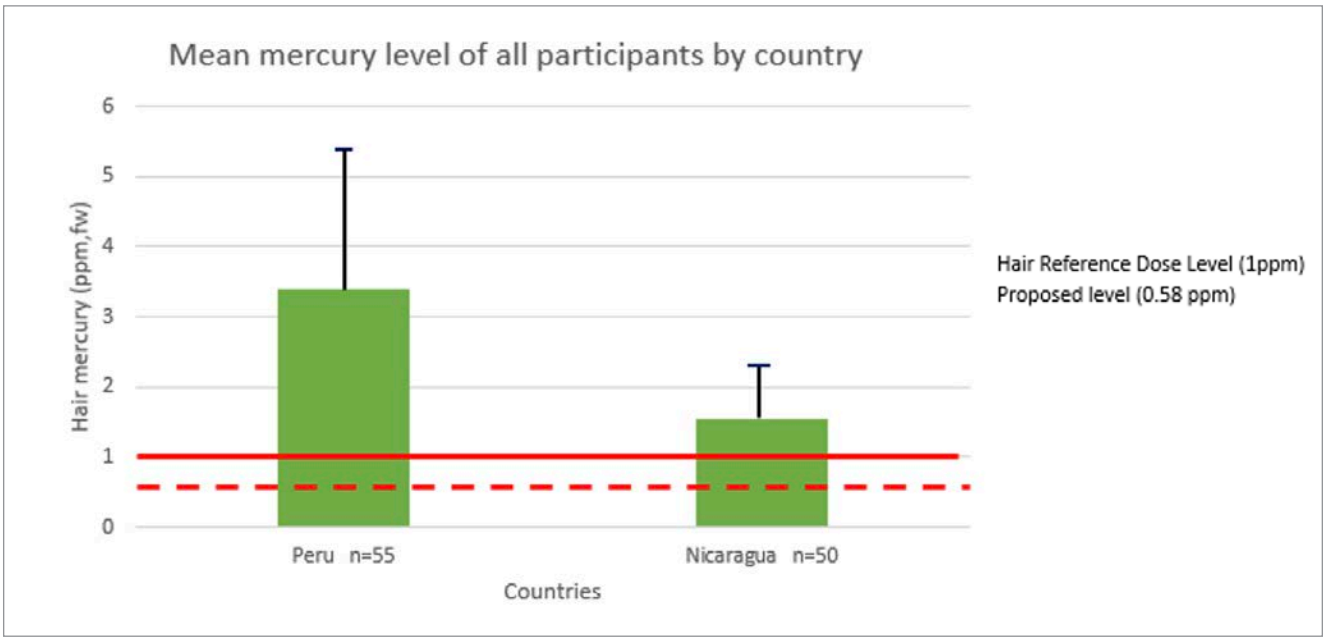


Figure 2. Mean mercury level of all participants by country

Table 2. Results of participant hair analysis for total mercury content in four locations in Peru

LOCATION IN PERU	NUMBER OF SAMPLES	MEAN MERCURY CONCENTRATION WITH STANDARD DEVIATION (PPM)	NO. OF SAMPLES GREATER THAN 1 PPM	PERCENTAGE OF SAMPLES GREATER THAN 1 PPM	PERCENTAGE OF SAMPLES GREATER THAN 0.58 PPM	HIGHEST LEVEL RECORDED
Community 2	8	2.26 ± 1.17	7	87.5%	100%	4.08 ppm
Community 3	6	3.28 ± 2.28	6	100%	100%	7.26 ppm
Community 4	18	2.78 ± 1.35	18	100%	100%	7.53 ppm
Community 1	23	4.33 ± 2.43	23	100%	100%	9.44 ppm

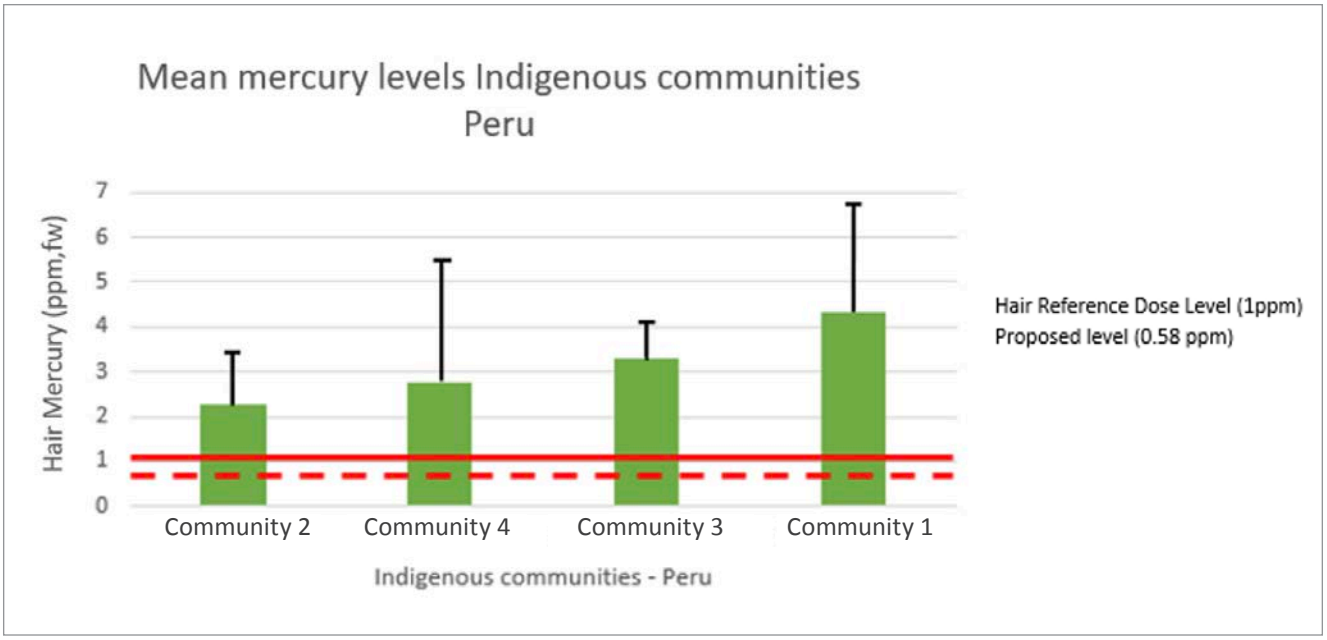


Figure 3. Mean mercury levels Indigenous communities Peru

Table 3. Results of participant hair analysis for total mercury content in two locations in Nicaragua

LOCATION IN NICARAGUA	NUMBER OF SAMPLES	MEAN MERCURY CONCENTRATION WITH STANDARD DEVIATION (PPM)	NO. OF SAMPLES GREATER THAN 1 PPM	PERCENTAGE OF SAMPLES GREATER THAN 1 PPM	PERCENTAGE OF SAMPLES GREATER THAN 0.58 PPM	HIGHEST LEVEL RECORDED
Li Lamni	25	1.57 ± 1.00	20	80%	96%	4.64 ppm
Li Aubra	25	1.52 ± 0.71	19	76%	100%	3.57 ppm

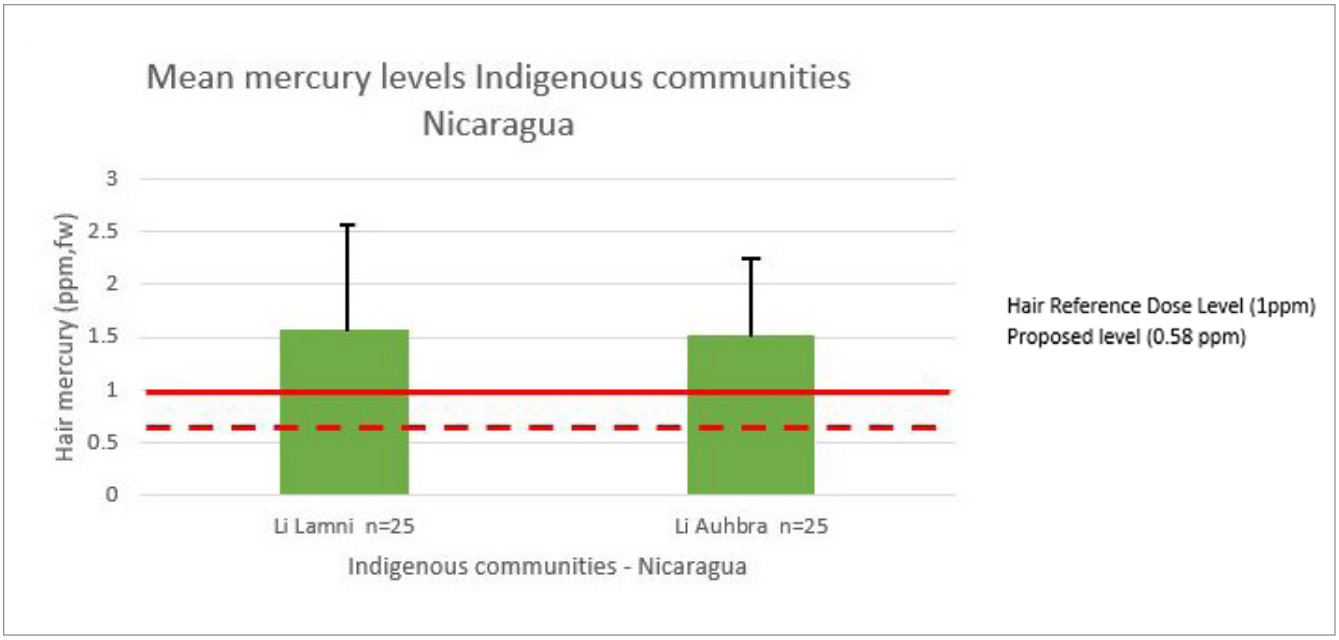


Figure 4. Mean mercury levels Indigenous communities Nicaragua

The IPEN/BRI sampling methodology only considers results from women aged between 18 and 44 years as this allows direct comparison with results from former sampling projects using the same methodology. From time-to-time, samples are taken from participants who exceed this age limit but never from participants under the age of 18. In the case of participants from Nicaragua, seven women who provided samples were over 44 years old. The results from their samples have not been aggregated with the rest of the cohort that were within the target age range. Their results were similar to other women in the Li Lamni and Li Auhbra communities. The results from this group of seven women (aged 45-63) are presented for transparency but are not included in the overall results of the project.

Table 4. Mean mercury concentrations for women in Nicaraguan communities outside the age bracket for sampling.

LOCATION IN NICARAGUA	NUMBER OF SAMPLES	MEAN MERCURY CONCENTRATION WITH STANDARD DEVIATION (PPM)	NO. OF SAMPLES GREATER THAN 1 PPM	PERCENTAGE OF SAMPLES GREATER THAN 1 PPM	PERCENTAGE OF SAMPLES GREATER THAN 0.58 PPM	HIGHEST LEVEL RECORDED
Li Lamni (2) Li Auhbra (5)	7	1.62 ± 0.54	6	85%	100%	2.60 ppm

5. ASSESSMENT AND DISCUSSION

PERU

The results from the four Indigenous communities along the Madre de Dios River in Peru were highly elevated for all communities with all participants exceeding the 0.58 ppm proposed level and all but one participant exceeding the 1 ppm reference level. Most participants from this region exceeded the 1 ppm level by a large amount, with the mean level of all participants at 3.40 ppm ± 2.08 ppm fw (standard deviation). The highest level recorded was very high at 9.44 ppm total mercury. Of all the Peruvian participants, 39 (70%) exceeded 2 ppm, 14 (25%) exceeded 4 ppm, and 7 (12%) exceeded 6 ppm.

Overall, the lowest mean levels were found in Community 2 (2.26 ± 1.17 ppm fw), with the next highest in Community 4 (2.78 ± 1.35 ppm fw), then Community 3 (3.28 ± 2.28 ppm fw), and finally, Community 1, which was the most impacted community with a mean level of 4.33 ± 2.43 ppm fw.

In these communities, most of the participants were engaged in domestic work or agriculture with some who are students, teachers, and merchants. The four communities have a diet very high in fish, with most women eating fish 3 to 7 times a week, with some saying they will eat fish every opportunity they have. Common species noted on the questionnaires as regularly consumed were different varieties of locally caught catfish and other species including boquichico, paco/paku, carachma, yahuarachi, yulilla, chambira, doncella, palometa, and corvina.

Previous studies have identified levels of mercury in fish that exceed the national consumption standards in areas of the Madre de Dios River occupied by the participants in this study (Diringer et al., 2015; Wyatt et al., 2017). Given the frequency and volume of fish consumed in the participating Indigenous communities and lack of occupational exposure (no participants indicated involvement in ASGM), it can be assumed that their mercury exposure is primarily dietary.

NICARAGUA

Participants from the Li Lamni and Li Auhbra Indigenous communities in Nicaragua live along the Rio Wangki (also known as the Rio Coco) where there are many small-scale gold mining operations. Some members of these communities also participate in gold extraction.

The average levels of mercury among the Li Lamni community participants were 1.57 ± 1.00 ppm fw THg, exceeding the reference level of 1 ppm. The highest level recorded was 4.64 ppm. Of all participants from this community, levels in 80% exceeded the reference level of 1 ppm and 96% exceeded the proposed level of 0.58 ppm.

Among the Li Auhbra participants, average levels of 1.52 ± 0.71 ppm fw (total Hg) were very similar to the Li Lamni participants' results. The highest level recorded from the Li Auhbra community was 3.57 ppm. Of all participants from this community, levels in 76% exceeded the reference level of 1 ppm, and 100% exceeded the proposed level of 0.58 ppm.

Questionnaires indicated very similar diets between the participants in the two communities in terms of seafood species and quantities consumed. Participants named fish consumed regularly as robalo, barbudo, bachi, tilapia, wapote, tuba, and mas mas. Shrimp (camarones) and crabs (cangrejos) were also consumed regularly.

The Nicaraguan cohort mostly had elevated levels of mercury, but their fish diet varied in composition from the Peruvian cohort, leading to lower mercury values across all ages despite high fish consumption. A key factor when comparing the highly elevated levels in the Peruvian cohort with the less elevated levels of the Nicaraguan cohort is the type of seafood being consumed. Whereas the Peruvian cohort consumed large quantities of carnivorous catfish and other predatory fish species that accumulate mercury, the Nicaraguan cohort had a large component of shrimp and crabs in their seafood diet and less fish.

None of the participants from Peru identified shrimp or crabs in their diet but did include mostly carnivorous fish including piranha species. Shrimp and crab do not tend to accumulate mercury to the same level as predatory, carnivorous fish species (McCormick et al. 2020), and the abundance of shrimp and crab in the Nicaraguan cohort's diet may be responsible for the overall lower mercury body burden in the participants from Li Auhbra and Li Lamni. However, studies have identified significant mercury concentrations in some crab species which seem dependent on local contamination impact levels (Rodrigues et al. 2024). Direct sampling of crabs and shrimp in the Rio Wangki for mercury concentrations would give a better level of understanding of the lower mercury levels found in participants from this region compared to their Peruvian counterparts.

Among the Nicaraguan participants, 12 individuals self-identified as 'gold washers', which involves the panning of gold-bearing ore and the use of mercury for extraction. Interestingly, the mean levels of mercury in hair among this group were 1.28 ppm, which is slightly lower than the mean for the entire cohort of Nicaraguan participants (1.54 ± 0.85 ppm fw). The gold washers also indicated that they were aware of the hazards of mercury and took precautions, although these were not elaborated. Presumably, it involved some form of protective equipment (e.g., masks and gloves).

The Rio Wangki (also known as Rio Coco) has also been the subject of several studies that have demonstrated ASGM impact leading to mercury contamination of fish and local communities. The circumstances of these communities along the Wangki River are similar to the Li Auhbra and Li Lamni communities with high consumption of fish and crustacea from the river.

CONCLUSIONS

Overall, for the Peruvian cohort, only one participant had mercury levels below the 1 ppm reference level, and none were below the 0.58 ppm proposed level. The mean mercury level for this group was highly elevated, indicating that mercury contamination in the aquatic food chain from ASGM activity is severe and can cause mercury-related health impacts on women of childbearing age in the four Indigenous communities where sampling took place.

For the Nicaraguan cohort, the levels were also elevated for most participants, but not to the same degree as the Peruvian cohort. In total, 80% of the participants exceeded the 1ppm reference level, and 98% exceeded the 0.58 ppm proposed level. Health impacts from food chain contamination in the two Indigenous communities may be taking place and could increase over time as mining activity continues to impact the aquatic environment.

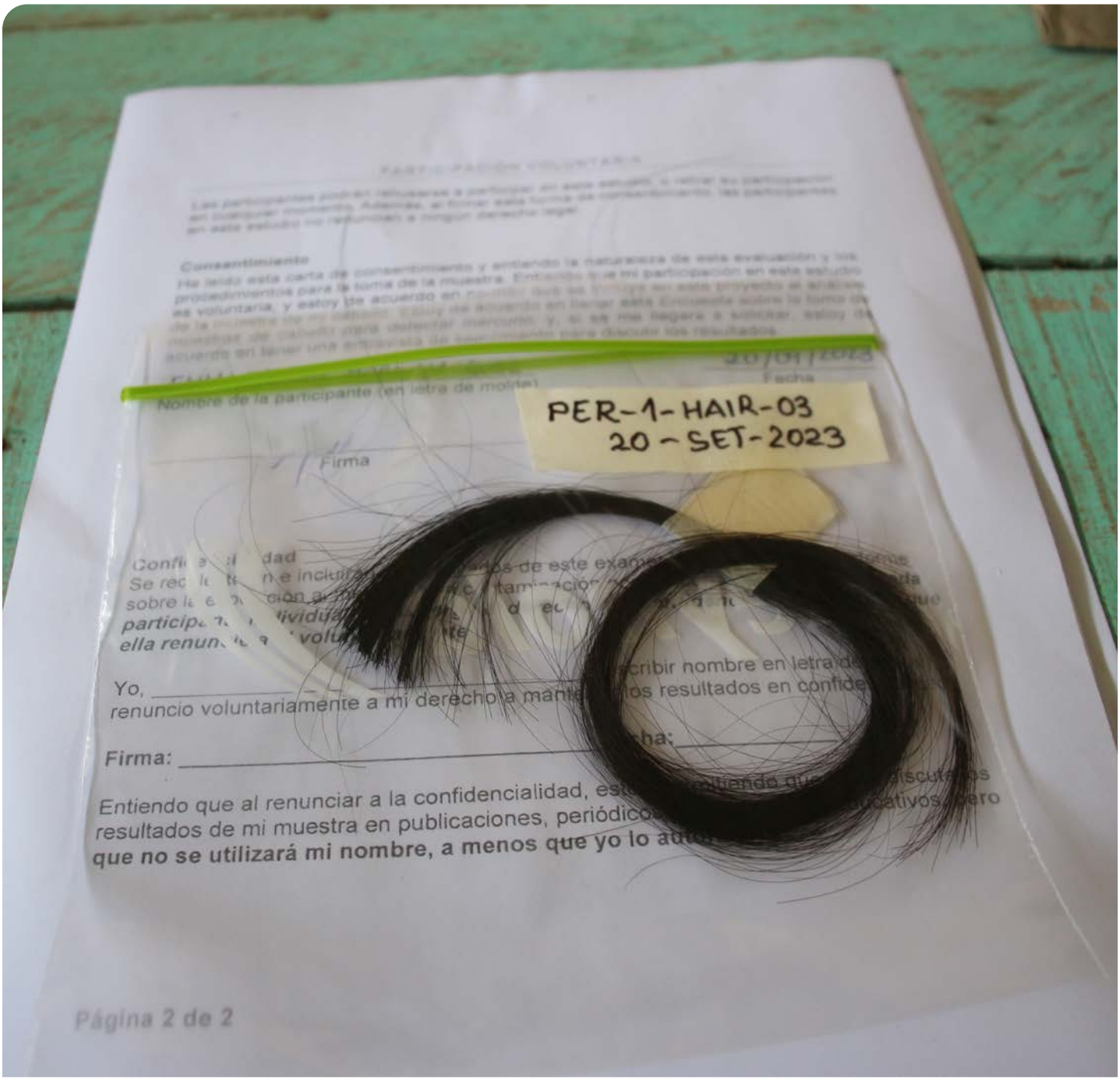
The results from this sampling project clearly indicate that women of childbearing age in Peru and Nicaragua are being impacted by mercury contamination of their environments. Their heavy reliance on locally caught fish and seafood, while an important source of protein and healthy fatty acids (e.g., omega-3), is a direct source of mercury exposure from the food chain that is contributing to an increased body burden of mercury in Indigenous communities proximate to the river.

The levels of mercury among the Indigenous women participants from Peru exceeded recommended mercury threshold limits by more than 300% on average and should instigate a health support intervention from the Peruvian government to assess the community for mercury intoxication and provide appropriate treatment. While the Government of Peru declared by Supreme Decree No. 034-2016-PCM[31] the Madre de Dios region to be in a public health emergency, local Indigenous communities taking part in this study expressed concern that mercury-specific health support has been lacking. With little to no alternatives for dietary protein for the Indigenous communities in the Madre De Dios region in Peru and the Rio Wangki region in Nicaragua, the respective authorities should take action to prevent the use of mercury in gold extraction in their countries.

31 https://www.actualidadambiental.pe/wp-content/uploads/2016/05/Decreto-Supremo-034-2016-PCM.pdf

More broadly, while the extraction of gold using mercury provides some economic support for miners and royalties for government (if it is even declared), the national economic impacts of food chain contamination and loss of development and IQ potential in the population impacted by mercury, far outweigh the economic gain for the few miners who succeed in extracting significant amounts of gold.

Clearly, the regulations created by the Minamata Convention are not strong enough to prevent the use of mercury for gold extraction, food chain contamination, and the unfettered global trade in mercury that ends in ASGM. IPEN recommends that the Minamata Convention on Mercury be amended as soon as possible to end primary mercury mining immediately, prevent the international trade in mercury and establish a phase out date for its use in ASGM – measures that are not currently part of the Convention. Both Peru and Nicaragua can also independently go beyond compliance with the Convention and ban imports of mercury and prohibit its use in ASGM. Both governments have a responsibility to protect their Indigenous Peoples from the increasing levels of mercury contamination caused by gold extraction.



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