

Impacts of Artisanal and Small-Scale Gold Mining (ASGM) in the Peruvian Amazon

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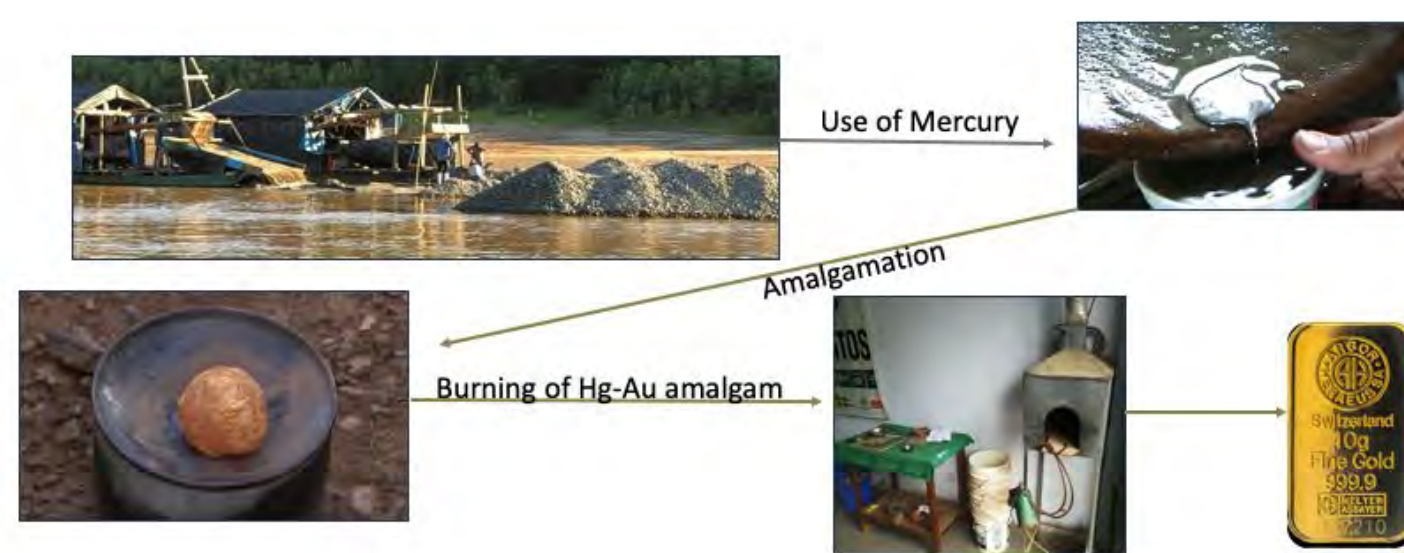


BASS
CONNECTIONS

Background

- Mercury (Hg) is used to extract gold from sediment and ore in ASGM
- Hg is ranked the 3rd most toxic element by the Agency of Toxic Substances and Disease Registry²
- 70% of Peru's artisanal gold production comes from the Amazonian region of Madre de Dios (MDD), where 100% of ASGM uses Hg⁴
- Consumption of Hg-contaminated fish is believed to be the main source of human Hg exposure in MDD, though alternative exposure pathways such as via other foodstuff have not yet been evaluated³
- Average human hair Hg concentrations in MDD exceed the USEPA provisional level that could result in child developmental impairment⁵⁻⁸
- Communities >150 km upstream of ASGM have the highest hair Hg concentrations,⁸ leading to questions on Hg transport pathways

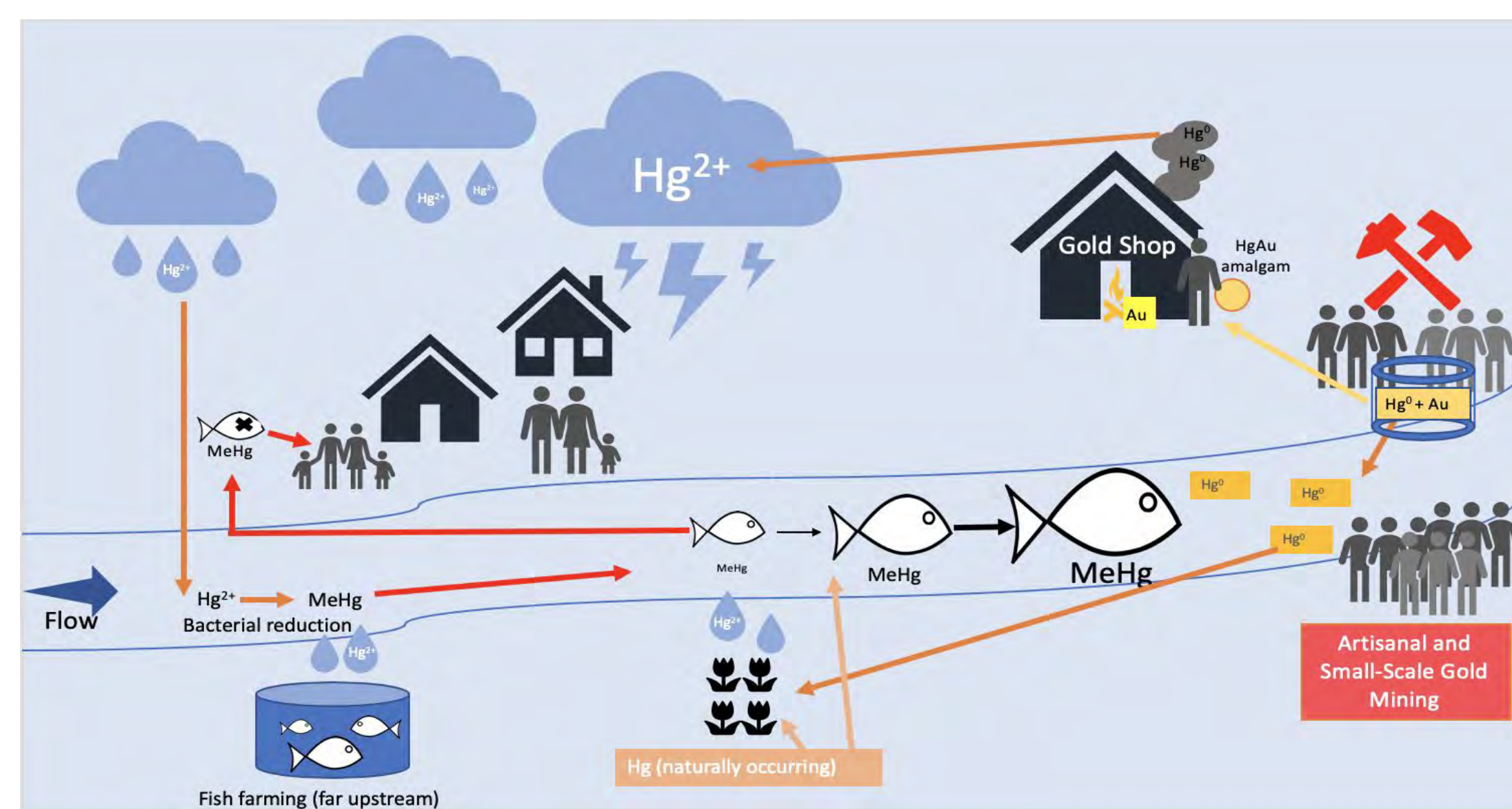
The process of Gold (Au) Extraction



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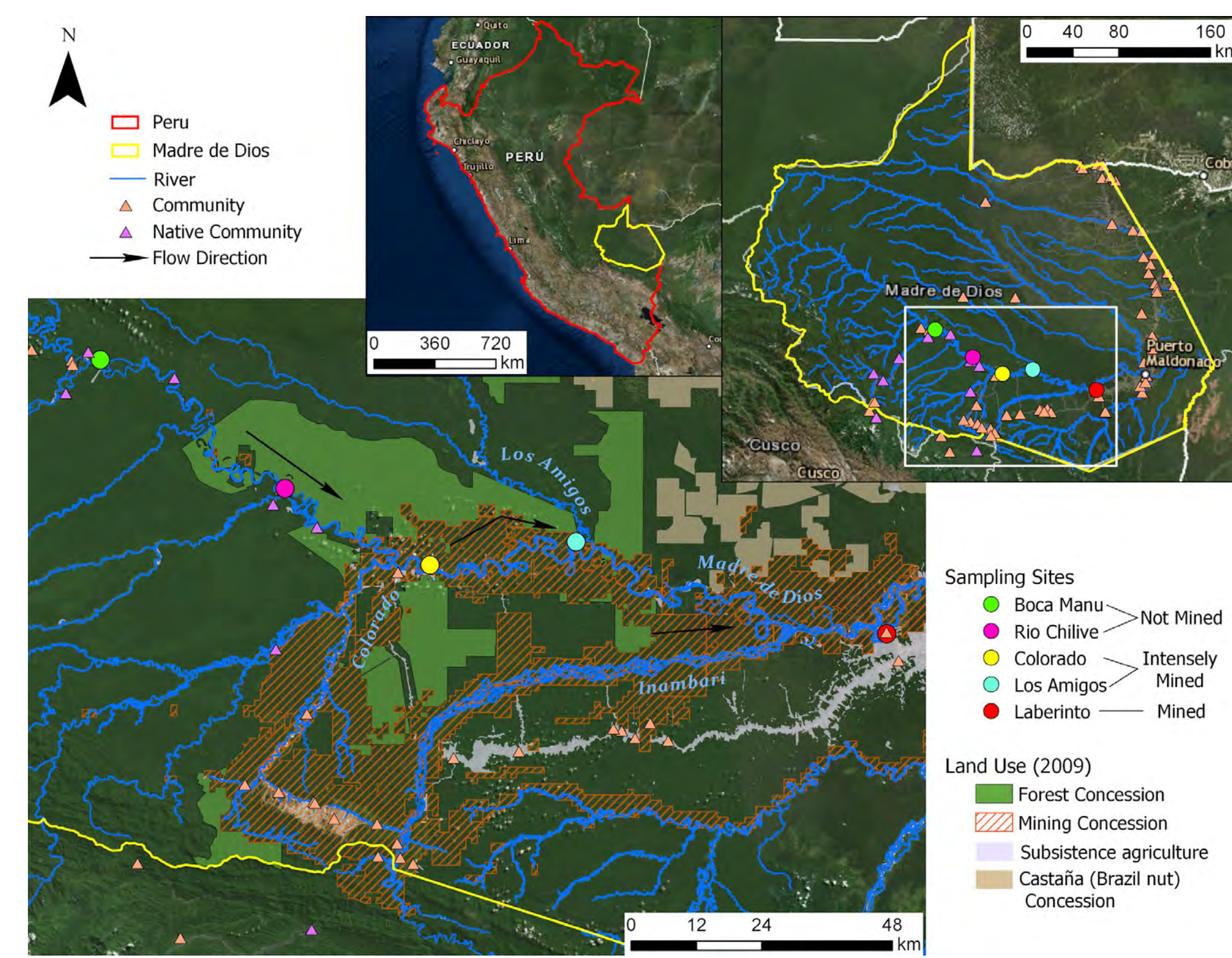
Project objectives

- Determine Hg transport pathways in the environment
- Determine which foodstuffs are accumulating Hg and in what quantities
- Provide information on the fate of Hg in the environment and foodstuffs to inform policy and law strategies

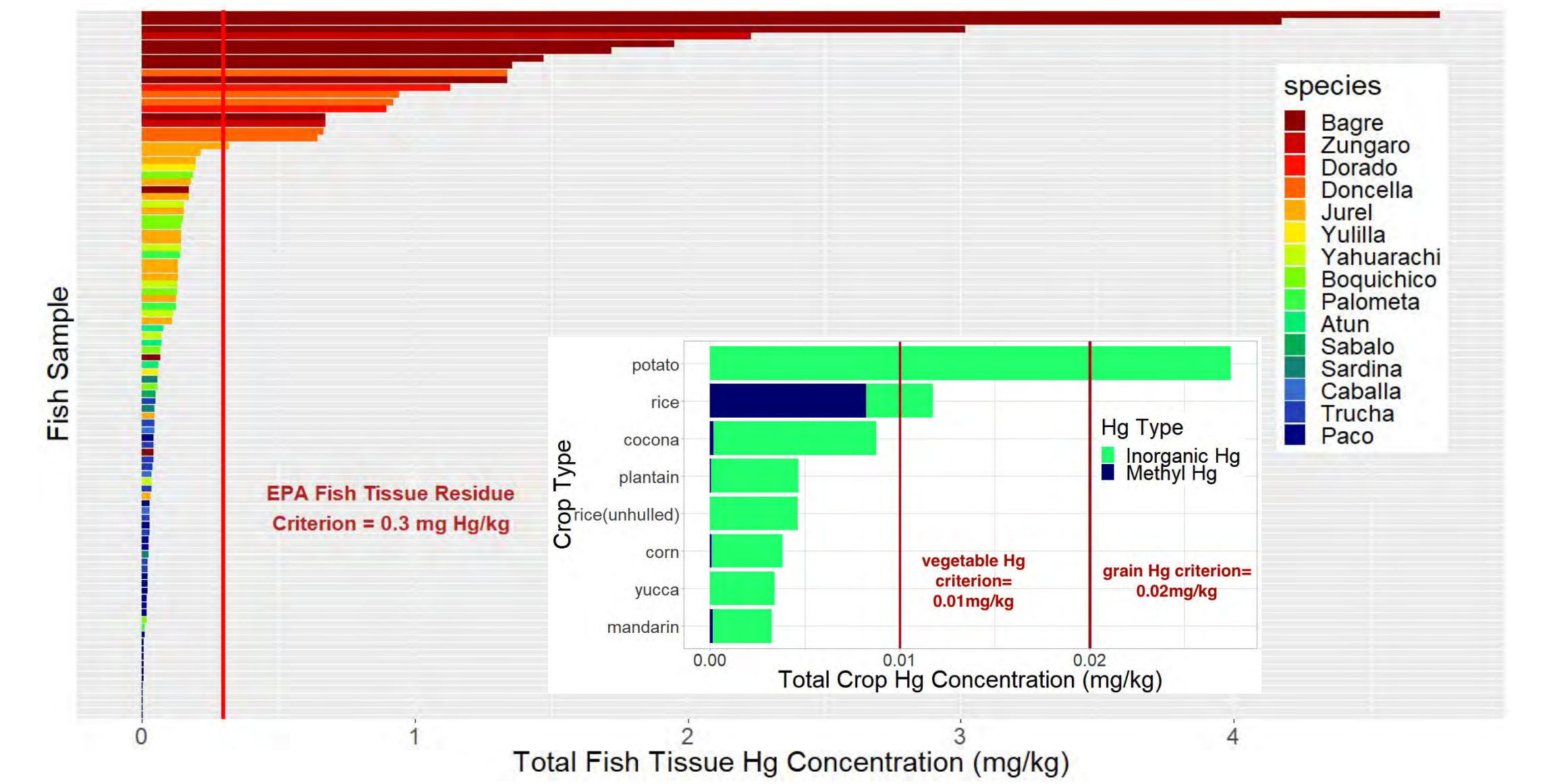


Methods

- Samples of crops, fish, and precipitation were collected in July, August, and December 2018 in Madre de Dios, Peru in three zones: not mined, intensely mined, and mined
- Surveys were administered in eight communities to gather diet and demographic information
- Total & methyl Hg were analyzed in crops/fish/precipitation and policy/law were analyzed to inform key stakeholders



Hg Concentrations in Foodstuffs

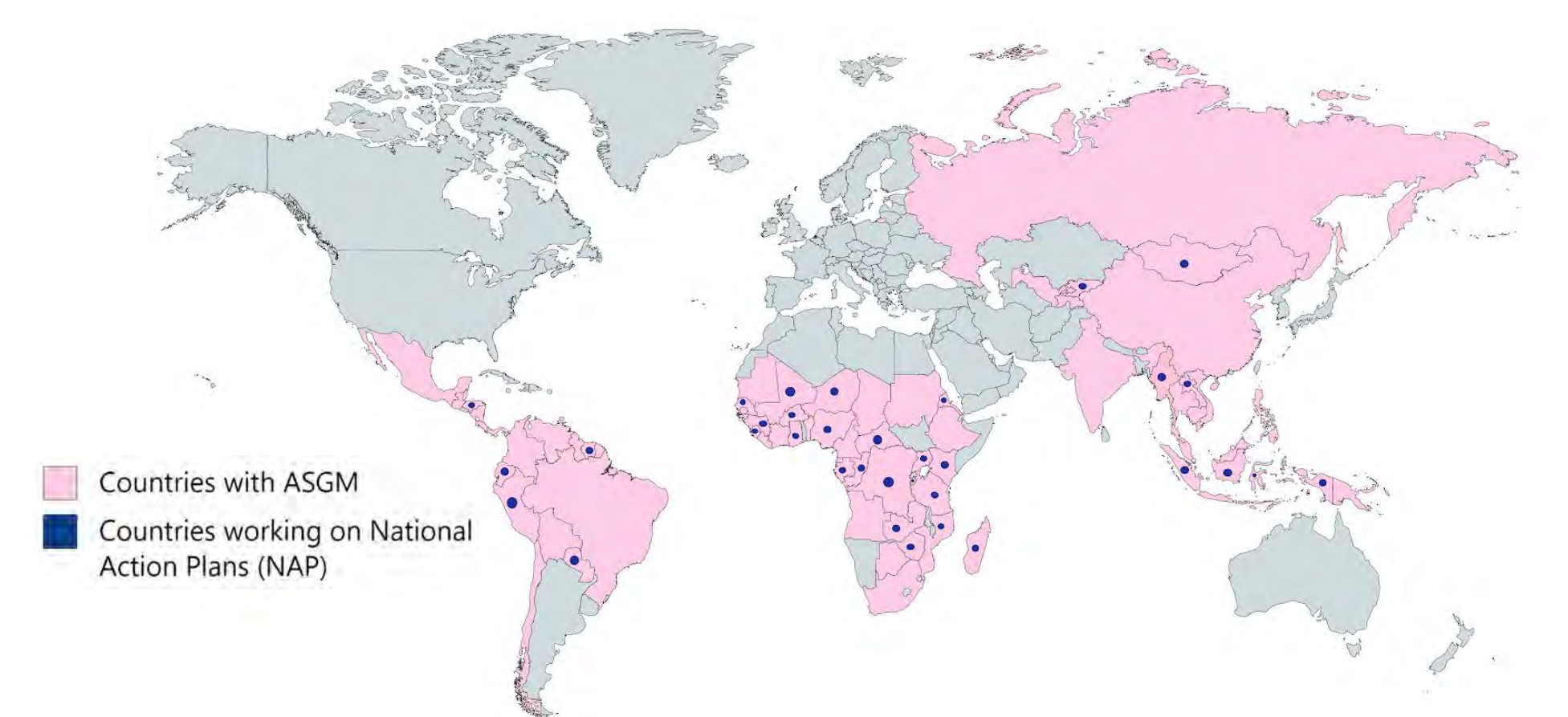


- All fish (98) and crops (50) had detectable Hg concentrations
- 38% of crop samples had detectable methyl Hg concentrations
- 19.4% of fish samples exceeded the USEPA fish tissue residue criterion for Hg
- 18% of crop samples exceeded published crop Hg standards for foodstuffs (based off criterion available only in China⁹)

Recommendations

Recommendations for the people of Madre de Dios:

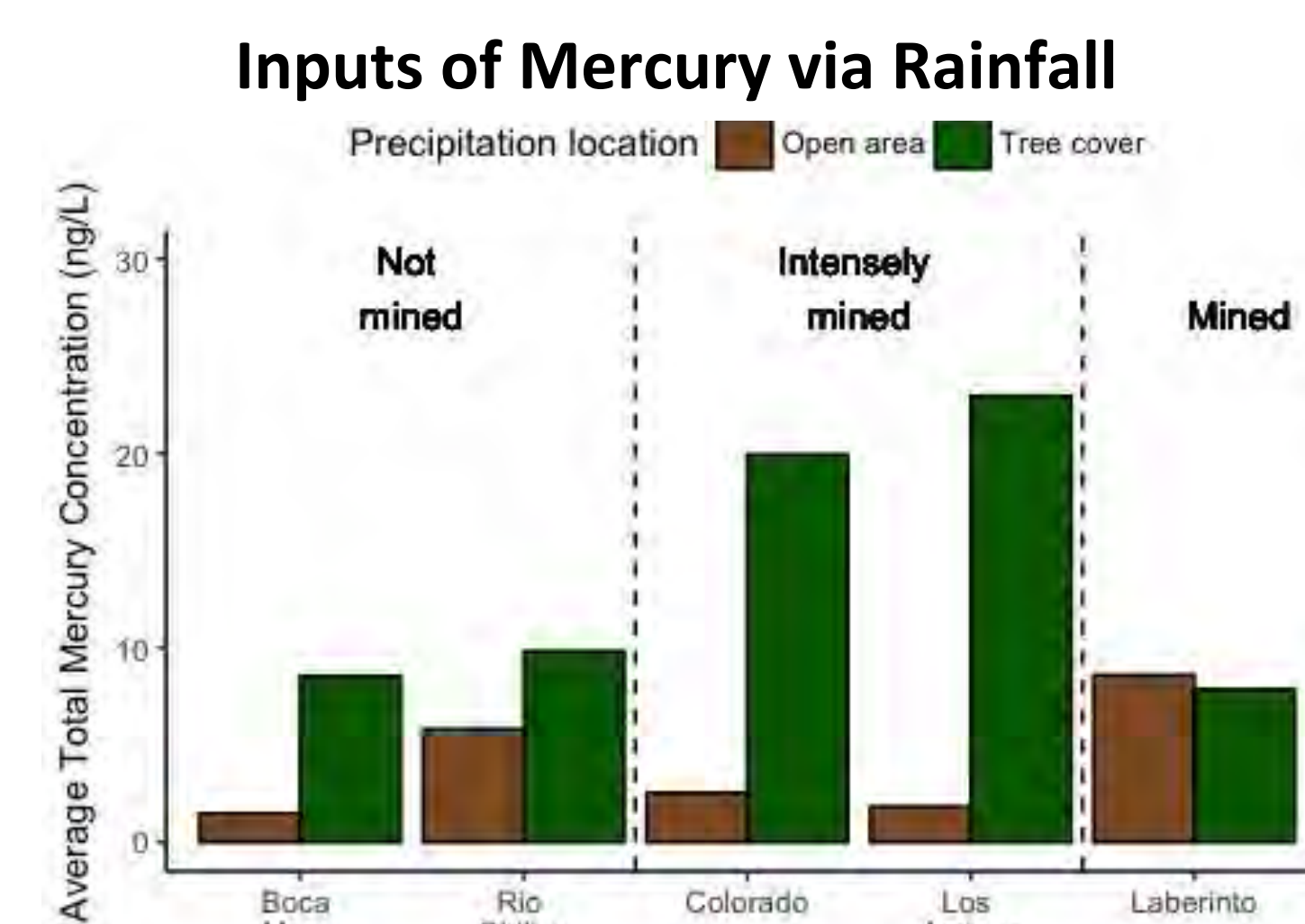
- Farmed paco offer a low Hg source of fish and can be consumed frequently
- Carnivorous, long-lived fish such as bagre, zungaro, dorado, and doncella should be eaten infrequently



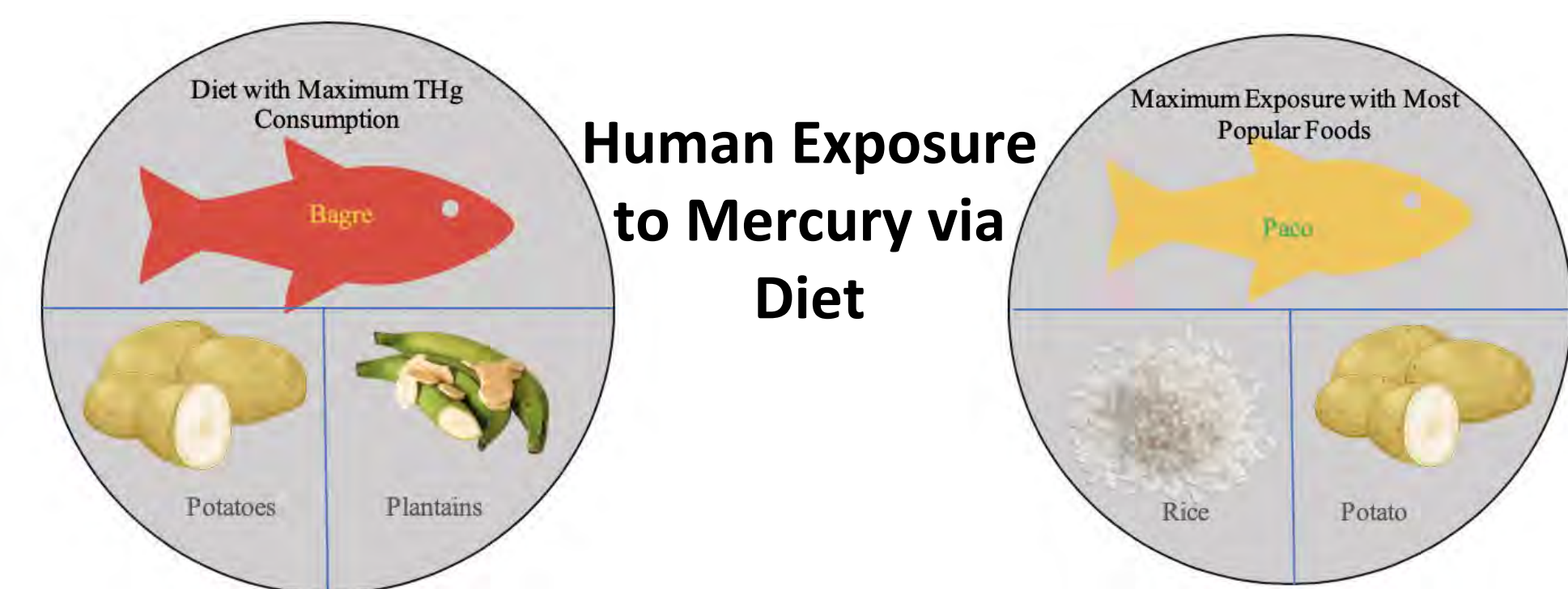
Recommendations for the Peruvian government:

- Establish relationships between scientists, policy makers, and relevant stakeholders to use science research to inform policy and decision-making¹¹⁻¹²
- Monitor Hg content in environmental compartments to provide local populations with relevant information
- Increase education programs for community members to decrease their exposure to Hg via foodstuffs
- Incentivize alternatives to income generation in the ASGM regions
- Promote better methods to continue ASGM without the use of Hg
- Authorize mandatory monitoring and evaluation at every multisectorial level
- Update and integrate the legal framework to establish a include strategies that span across different government sectors working on ASGM

Overall Environmental and Human Hg Exposure



- Hg from ASGM is entering the environment via rainfall and is enhanced under tree cover
- Hg in precipitation near ASGM is higher than in precipitation near coal-fired power plants in the United States



	Diet Number 1 (Max Fish)			
	Max Eaten (kg/week)	Max Hg (mg/kg)	Max Exposure (mg/week)	mg/day
Bagre	7.01	4.76	33.35	4.76
Plantain	13.13	0.08	1.04	0.15
Potato	12.47	0.15	1.9	0.27
Total Exposure in One Meal				5.18

*Almost 20 times higher than the Provisional Tolerable Daily Intake set by the WHO of 0.2716 mg/day of THg.

	Diet Number 2 (Min Fish)			
	Max Eaten (kg/week)	Max Hg (mg/kg)	Max Exposure (mg/week)	mg/day
Paco	7.01	0.04	0.31	0.04
Rice	2.96	0.04	0.12	0.02
Potato	12.47	0.15	1.9	0.27
Total Exposure in One Meal				0.33

*1.2 times higher than the Provisional Tolerable Daily Intake set by the WHO of 0.2716 mg/day of THg.

¹ UNEP. United Nations Environment Programme (2013). Mercury: Time to Act. Updates from the UNEP Global Mercury Assessment 2013. United Nations Environment Programme, Nairobi, Kenya. 2 Rice KM, Walker EM, Wu M, Gillette C, Blough ER (2014) Environmental Mercury and Its Toxic Effects. *J Prev Med Public Health* 47(2): 14-43. 3 Ha E, Baeu N, Soae-O'Reilly S, Dorea JG, McCloskey E, Sakamoto M, Chan HM (2017) Current progress on understanding the impact of mercury on human health. *Environ Res* 152:419-433. 4 Beal SA, Jackson BP, Kelly MA, Stroup JS, Landis JD (2013) Effects of historical and modern mining on mercury deposition in southeastern Peru. *Environ Sci Technol* 7(22):101021-101021. 5 Ahe K (2012) Elevated Mercury Concentrations in Humans of Madre de Dios, Peru. *PLoS ONE* 7(3): e33305. 6 Langeland AL, Hardin RD, Nitzel RL (2017) Mercury Levels in Human Hair and Farmed Fish near Artisanal and Small-Scale Gold Mining Communities in the Madre de Dios River Basin, Peru. *Int J Environ Res Public Health* 14(3):302. 7 Washhouse C, Ortiz EJ, Berky AJ, Butler P, Hane-Gregg J, Rogers L, Morales A.M, Hsu-Kim H, WK (2017) Hair Mercury Level is Associated with Anemia and Micronutrient Status in Children Living Near Artisanal and Small-Scale Gold Mining in the Peruvian Amazon. *Am J Trop Med Hyg* 97(6):1898-1897. 8 Wyatt L, Ortiz EJ, Feingold B, Berky A, Drieger S, Morales AM, Jurado ER, Hsu-Kim H, Pan W (2017) Spatial, Temporal, and Dietary Variables Associated with Elevated Mercury Exposure in Peruvian Riverine Communities Upstream and Downstream of Artisanal and Small-Scale Gold Mining. *Int J Environ Res Public Health* 14(12):1582. 9 USDA FAS Beijing Staff (2018). China Releases the Standard for Maximum Levels of Contaminants in Foods 10 Chen C, et al. (2018) A Critical Time for Mercury Science to Inform Global Policy. *Environ Sci Technol* 52:9556-9561. 11 Driscoll C (2013) Mercury as a Global Pollutant: Sources, Pathways, and Effects. *Environ Sci Technol* 47:4967-4983. 12 Gustin M, et al. (2016) Importance of Integration and Implementation of Emerging and Future Mercury Research into the Minamata Convention. *Environ Sci Technol* 50(6). 13 ILO (1999) Social and labour issues in small-scale mines. Report for discussion at the Tripartite Meeting on Social and Labour Issues in Small-scale Mines, Geneva, Switzerland. 14 Barreto L. (2011) Analysis for stakeholders on formalization in the artisanal and small-scale gold mining. Alliance for Responsible Mining.