

Gold Mining in Brazil's Amazon Rainforest is a Major Contributor to Malaria Outbreaks

Small-scale gold mining in remote areas of the Brazilian Amazon rainforest results in mosquito breeding grounds which in turn leads to surges in malaria transmission. Small-scale gold mining has become a common means of income for low-income laborers in and around the Amazon. These small mining operations carve out new forest-edge environments in what was previously dense forest. When combined with populations of migrant miners in unsafe conditions, these environmental changes promote malaria outbreaks that ripple far beyond miner encampments. In order to reach the goal of eliminating malaria in Brazil by 2030, persistent malaria transmission within gold mines and as a result of newly deforested areas urgently needs to be addressed.



Photo credit: João Laet

Executive research summary

Recent research conducted by ecologists and economists at Stanford University shows that when small-scale mining activities emerge in rainforest ecosystems, malaria outbreaks soon follow. Unlike intact rainforest, clear-cut alluvial gold mining terrain (like that pictured above and on the following page) increases the abundance of the mosquito species responsible for transmitting the malaria parasite from human to human.

Deforestation and other mining activities destroy forest ecosystems and create swaths of standing, pooled water where mosquitoes thrive and reproduce. Compounding the situation, miners rarely have high-quality housing, usually residing in makeshift residences without adequate protection from mosquitoes. This results in mining regions with rampant mosquitoes and many humans without any protection against them. The life-cycle of vivax malaria also makes matters worse – when miners return home from the forest, they can be asymptomatic and unknowingly bring malaria home with them; one mosquito bite could then spread the disease beyond mining encampments and into towns and cities.

[CITATION PLACEHOLDER]

Key facts

Ending or reducing gold mining in the Brazilian Amazon is a major step toward combatting malaria and deforestation simultaneously — municipalities should utilize this knowledge in their regional efforts to eliminate malaria.

Mining operations in forest lands cause outbreaks of malaria cases, making them a key obstacle to malaria elimination in Latin America.

Small-scale mining operations in the Brazilian Amazon create unnatural forest-edge environments with clear-cut forest and pools of stagnant water, ideal mosquito breeding habitats.

Migrant workers live in informal settlements without adequate mosquito protection, resulting in increased mosquito exposure.

These conditions result in malaria outbreaks in gold mining regions, that then spread back to cities and towns when the miners return home.

On average, an additional kilogram of gold production in the Brazilian Amazon results in an additional 59 cases of *P. vivax* malaria, and for each square kilometer of forest cleared, roughly 6.4 additional malaria cases are observed.



Case study: Lessons from Costa Rica

Gold mining in the tropics is often associated with malaria. Alluvial mining and the informal encampments occupied by migrant workers create an environment that is conducive to mosquito breeding and parasite transmission. In the late 2010's, Costa Rica experienced a malaria resurgence caused by illegal gold mining.

2015: MALARIA ELIMINATED

Following a successful anti-malaria campaign, Costa Rica records zero cases of locally-transmitted malaria, a major victory that is lauded internationally.

2017: MALARIA RETURNS

After a 33-month period of no recorded malaria transmission, 12 cases are recorded.

2018: MALARIA GROWS

Locally-transmitted malaria cases increase to 70. Upon further investigation, researchers find that transmission is stemming primarily from migrant workers associated with an illegal open-pit gold mining region near the northern border.

Chaves, L. F. et al. Malaria elimination in Costa Rica: Changes in treatment and mass drug administration. *Microorganisms* 8, 984 (2020).

Brief prepared by the Action Lab for Planetary Health (ALPHA), an evidence-to-impact initiative based at the Stanford Center for Innovation in Global Health, in collaboration with the Mordecai Lab. For more information, visit www.globalhealth.stanford.edu/programs/alpha or contact Erika Veidis at eveidis@stanford.edu.

This research would not be possible without the following critical studies:

Douine, Maylis, et al. 2020. "Malaria in Gold Miners in the Guianas and the Amazon: Current Knowledge and Challenges." *Current Tropical Medicine Reports*, March.

Sanchez, Juan F., et al. 2017. "Unstable Malaria Transmission in the Southern Peruvian Amazon and Its Association with Gold Mining, Madre de Dios, 2001–2012." *American Journal of Tropical Medicine and Hygiene* 96 (2): 304–11.

Duarte, Elisabeth Carmen, et al. 2002. "Associação entre a produção anual de ouro em garimpos e incidência de malária em Mato Grosso - Brasil, 1985-1996." *Revista da Sociedade Brasileira de Medicina Tropical* 35 (6): 665–68.



INTACT ECOSYSTEMS KEEP DISEASE AT BAY

Ordinarily, rainforests are biologically diverse ecosystems, maintaining mosquito populations at low levels with natural competition and relatively few breeding grounds.



CLEARCUTTING & MINING CREATES MOSQUITO BREEDING GROUNDS

Mining results in a completely transformed landscape, with many pools of standing water and a totally altered ecosystem. In these environments, mosquitos thrive.



LIVING IN INFORMAL SETTLEMENTS, MINERS HAVE NO PROTECTION FROM MOSQUITOES

Migrant miners live in informal settlements without mosquito protection like sealed living spaces or mosquito nets. This sudden influx of people exposed to the malaria vectors in the forest can result in malaria outbreaks.



ASYMPTOMATIC MINERS BRING MALARIA HOME TO THEIR COMMUNITIES

When miners return to their home cities or town, they can unknowingly be infected with malaria, causing malaria outbreaks far from the mining sites.



SOLUTION: DEVELOP HEALTH SYSTEMS, WARNINGS, AND SUSTAINABLE LIVLIHOODS

- Make gold miners and communities aware of the malaria risks associated with their work
- Have national malaria programs work with environmental partners to co-create solutions that protect both human and ecosystem health
- Create viable economic alternatives for miners