In the Amazon, deforestation is linked to higher malaria rates

Enlarge / Aerial view of the Amazon rainforest, near Manaus the capital of the Brazilian state of Amazonas, Brazil.

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In Brazil, the rapid deforestation of the Amazon has been accompanied by a rise in malaria. But did the deforestation help increase malaria rates? Or is something more complicated going on?

Researchers Andrew MacDonald and Erin Mordecai think there is in fact a more complicated story at play. In a paper published in PNAS last week, they report evidence suggesting that deforestation does lead to a rise in malaria—but that at the same time, a rise in malaria reduces deforestation. The complicated relationship makes the effects difficult to tease out of the data. And together, the two effects mean that conservation and human health go hand in hand—what's good for one is good for the other.

Confusing evidence

Because malaria is spread by mosquitoes, it would be easy to think that humans have little to do with its prevalence if we're not killing mosquitos. But because human land use leads

to habitat change for disease vectors like mosquitoes, human activity can dramatically change the risks of vector-borne diseases.

And there's evidence that it has. By the early 1960s, Brazil had seemed to get a handle on its malaria problem, going from a reported 6 million cases every year to fewer than 50,000. But in the 1960s, malaria started skyrocketing again, reaching more than 600,000 cases every year by the 21st century.

This increase paralleled deforestation, but that's where things get tricky. Did deforestation cause the malaria increase, or are they both the result of something else? Reasoning dictates that deforestation directly boosts the risk of malaria because it creates a friendlier environment for mosquitoes.

But research on the question has been inconclusive. In some cases, researchers have found a correlation between deforestation and higher rates of malaria. In others, results have shown the complete opposite—that higher malaria incidence was actually associated with forest *conservation*. There's a sensible explanation for this effect, too—a population struggling with a high malaria burden isn't going to have the same economic output (including deforestation) as a healthy one, especially in places where its individual settlers are doing the forest clearing.

So what exactly is going on here? "As a growing human population continues to expand into and clear primary forest across the globe," write MacDonald and Mordecai in their paper, "should we expect increased transmission of human malaria?"

Not a simple relationship

To answer this question, MacDonald and Mordecai used data that tracked malaria rates across Brazil between 2003 and 2015.

They compared this to a global dataset tracking forest cover and deforestation, avoiding Brazilian government data on deforestation because of concerns that it wasn't all that reliable.

They also baked in other information that varied from place to place and could have an effect on malaria transmission, like temperature and precipitation. And they kept track of important events like policy changes.

Their results showed a relationship between deforestation and malaria. In 2008—the midpoint of the time period they looked at—each 1,567km^2 that was lost to deforestation was associated with nearly 10,000 additional cases of malaria. But the pattern wasn't the same everywhere. In regions without much forest left, there wasn't much of a relationship between the two.

And here's the tricky bit: this effect didn't show up without first accounting for the opposite effect—more malaria leading to less deforestation. For each 3,000 cases of malaria, MacDonald and Mordecai estimate that 219km^2 of forest was retained.

Is it causal?

These results show a relationship between malaria and deforestation, but how did the researchers know whether the relationship was causal? Did deforestation definitely cause the malaria—and malaria definitely cause a drop in deforestation? It's not possible to say with certainty, but because MacDonald and Mordecai built so much detail into their model, they managed to rule out a lot of other plausible explanations.

They also found similar results when they tweaked the model and tried it out with different data, suggesting that the

results are pretty robust. Still, public health could do with more detailed research on nitty-gritty local data to understand precisely how these two factors are related.

The finicky bidirectional relationship explains why it has been hard to find consistent evidence on how deforestation and malaria are related. And as deforestation in the Amazon continues apace, the clarity brings a warning: the impacts of deforestation go beyond the dire effects on conservation and climate.

PNAS, 2018. DOI: 10.1073/pnas.1905315116 (About DOIs).

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