

GEH Global Environmental Health Chat

RAINFOREST ECOSYSTEMS: The Amazon, Deforestation, and Malaria

(NIEHS Grantee) Name (Amazon): Erin A. Mordecai, Stanford University

Article (Pubmed): [Amazon deforestation drives malaria transmission, and malaria burden reduces forest clearing](#)

NIGMS Research: [Leveraging environmental drivers to predict vector-borne disease transmission](#)

GEH Global Environmental Health Chat

Ecosystem Services Part One Transcript

Narrator: This is the Global Environmental Health chat, the podcast that explores environmental health issues that transcend national boundaries. This podcast is produced by the National Institute of Environmental Health Sciences.

Narrator: An ecosystem consists of the community of organisms and their environment interacting together. Ecosystem services are the positive benefits, like food and shelter, or clean air and water, that ecosystems provide to people. In this two-part series, we will look at how human disruption of sensitive ecosystems affect not just their unique plants and animals, but also their ability to protect human health.

Narrator: In part one of this series, we speak with NIH grantee Erin Mordecai, Associate Professor in Biology at Stanford University and Senior Fellow in the Woods Institute for the Environment, about the importance of rainforests.

Narrator: Tropical rainforests are the most biologically diverse terrestrial ecosystems in the world. Their diversity and unique ecosystems play a critical role on Earth.

EM: [0:37] “Rainforests are hugely important to the planet for many, many reasons. They are really unique ecosystems that have a very high level of biodiversity, meaning they contain lots of different species, lots of genetic diversity, lots of ecological interactions. And because of all of this diversity, they also can, they also provide lots of what some people call ecosystem services, so they're able to help maintain good water quality, good air quality, because they're forests, they tend to store a lot of carbon, both in the soils and in the trees and in the biomass that the trees put on.” [1:16]

EM: [2:27] “When we think about ecosystem services that rainforest might provide to humans, particularly those outside of the rainforest. Those include things like regulating the Earth's climate system, drawing down carbon from the atmosphere, and also protecting us from the emergence of disease. We see this most acutely in the loss of forests, when we start to see forests being cut down or converted into agriculture, or novel human encroachment into the forest, we start to see emergence of what we call vector borne disease.” [2:58]

Narrator: Rainforests and the ecosystem services they provide are under extreme threat from climate change, deforestation, and land-use changes from agricultural practices.

EM: [4:44] “One of the most acute threats to rainforests today is encroachment of humans and particularly large-scale deforestation. And the reason is because these forests don't grow back very easily. Once you lose the forest, you lose a lot of the positive feedback tend to maintain a healthy rainforest ecosystem, you can lose the plants and animals for example, you can lose the key animal species that serve as pollinators or seed dispersers.” [5:12]

EM: [6:00] “Deforestation and other types of human pressures on the rainforest present one of the most acute stresses on the rainforest ecosystems worldwide right now.” [6:09]

Narrator: One consequence of deforestation has been the emergence of vector borne diseases. Human-induced drivers such as climate change and deforestation are affecting the distribution and transmission of these diseases.

EM: [6:24] “Vector borne diseases are diseases that are transmitted by biting arthropods. So think of things like ticks, mosquitoes, fleas, flies, these diseases are unique in the sense that they require this biting vector in order for the disease to be transmitted to people.” [6:42]

EM: [7:44] “There's a lot of pretty familiar vector borne diseases that you may have heard of, including malaria, West Nile virus, Lyme disease, dengue fever, Zika, chikungunya, and there's many, many others. But it's also important to know that not all infectious diseases can be transmitted by vectors.” [8:01]

EM: [12:19] “The speed of transmission of these vector borne diseases really depends on temperature. And so that's why temperature is such a key determinant of the risk of a lot of vector borne diseases. Rainfall or the availability of standing water is also a really important determinant, particularly for mosquito borne diseases because of course, mosquitoes breed and standing bodies of water.” [12:38]

EM: [14:21] “And that's why there's so much complexity to understanding when we're going to have vector borne disease outbreaks because they're responsive to so many different aspects of the environment, from the climate, to the habitat to human behavior, to the kind of social and built environmental structures that humans are living in and residing in, that can really affect our exposure. So together all of these things determine the likelihood of a disease outbreak.” [14:45]

Narrator: Vector borne diseases present a serious global public health risk.

EM: [8:39] “Vector borne diseases are huge public health risks, and they occur in many parts of the globe. Malaria is probably the most famous, and it's had one of the most long-term impacts on humanity. There are, of course, very large malaria control programs now. But even despite all this money, and effort that goes into malaria control, we still see about 400,000 deaths or more per year from malaria in Sub Saharan Africa. And most of those are children under five and pregnant women.” [9:06]

EM: [9:52] “Lyme disease is another one that we're facing in North America. Increasingly, we're seeing 10s of 1000s of Lyme disease cases every year. And that's true, objected to get worse with climate

change as well. So vector borne diseases really pose a major threat to human health across the globe, although most of the impacts are concentrated in tropical and subtropical regions.” [10:12]

Narrator: Dr. Mordecai and her co-author Dr. Andrew MacDonald have been studying the relationship between deforestation and incidences of malaria in Brazil.

EM: [15:08] “In 2019, MacDonald and I published a paper on how deforestation and malaria are related to each other in the Amazon in Brazil in particular. And we're building on a body of research that has observed in many cases across many different parts of the Amazon, that you tend to see malaria outbreaks in places where there's deforestation. And some of this evidence was suggesting that people who are small scale farmers, or gold miners or other people that are kind of in the frontier of forest clearing the earliest settlers into the forest were most at risk of, of malaria, of malaria transmission. And what we wanted to know was more broadly, what is the risk of malaria in response to deforestation?” [15:54]

EM: [17:15] “Using pictures taken from satellites in space, we can measure deforestation over time. We can also measure changes in climate over time, the Brazilian government really carefully reports malaria cases. And so we had a database of malaria cases over time. And we were able to link up these datasets, and use some modeling tools from the field of applied econometrics, to sort of understand the causal relationship between deforestation and malaria.” [17:45]

Narrator: Their findings were consistent with their hypothesis that deforestation and malaria are related. Further, people living by the forest edge, known as the frontier stage, were particularly vulnerable to the effects of deforestation.

EM: [18:35] “Deforestation, particularly at the early frontier stage, tends to bring people in contact with forest edge, it creates new forest edge, of course, by cutting out part of the forest. And it places people in a vulnerable condition where the housing quality may not be so high, so they might not be sleeping under bed nets, or they might not have sealed windows and doors. The exposure is high, it often brings people into the Amazon region that haven't historically lived there, which can mean that they haven't had prior exposure or immune resistance to malaria. And so all of these conditions come together to cause this relationship that we hypothesize between deforestation and malaria. So what we found when we put together these different sources of data and statistical models, is that there was a strong effect of deforestation on malaria.” [19:26]

EM: [19:27] “For every square kilometer of forest that was cleared. We saw about 6.4 additional malaria cases. So six additional people are getting sick with malaria for every square kilometer of forest cleared. Interestingly, we also saw the evidence for this bidirectional feedback where for every malaria case that we saw, there was about point 07 fewer square kilometers of forest cleared, suggesting that not only is deforestation bad for the environment, and bad for health, but there's also this feedback where the health impacts in turn reduce the productivity of these deforested sites.” [20:05]

Narrator: This study highlights the ways rainforest ecosystems services can impact the spread and distribution of vector borne diseases.

EM: [21:36] “I think it's important to understand relationships between rain forest and forest clearing and human health, I think it's important to put numbers on those relationships, because otherwise, we're not going to account for the external impacts on humans. You know, we might think about forest protection as being mainly a conservation and biodiversity issue. And it certainly is, but I think it puts it in a different perspective, when you realize that there's this direct effect of forest. There's a direct effect of forest clearing on human health by causing infectious disease outbreaks like malaria, also by reducing water quality and reducing carbon storage and destabilizing the Earth's climate system.” [22:17]

EM: [22:39] “This problem goes beyond the Amazon, the Amazon is the world's largest remaining swaths of, of tropical rainforest. And that's one of the reasons that we really, you know, it's a really a focal point for the effects of deforestation on disease. But we do see relationships where forest clearing often leads to malaria outbreaks and other types of disease outbreaks in other parts of the world, ranging from Africa to Southeast Asia to Latin America. So it is a pretty widespread problem.” [23:05]

EM: [23:40] “I think there's lots of reasons that we should be thinking about protecting rainforest for the health of both people and the planet.” [23:46]

Narrator: Dr. Mordecai noted that local and indigenous communities and non-profit organizations can be stewards of conservation and help to mitigate the global burden of vector borne diseases.

EM: [26:04] “And their idea is that although this is a huge global problem, the solution lies in local communities and in pretrained, forest communities.” [26:10]

EM: “These local solutions often involve things like constructing a local health clinic, providing year-round access to malaria treatment and testing, providing basic medical coverage that people don't already have, that is really costly, and causes people to have to leave their land and leave the land open to degradation from outside forces, and also providing education and access to increase opportunities for forest livelihoods. Health in Harmony is doing a lot of this really important work in Indonesia, as well as Brazil and Madagascar, which are three of some of the most threatened and important rainforest communities in the world.”

EM: [26:45] “I think that's a great example of how we can think about people not only as destructive forces in ecosystems, but also as protective and collaborative forces that can help to protect rainforest ecosystems that are so important to the health of the entire planet.” [27:22]

Narrator: The National Institute of Environmental Health Sciences funds research to better understand the health effects of climate change. You can learn more about the institute's research by visiting our website at www.niehs.nih.gov/GEH. Thanks again to Dr. Erin Mordecai for joining us today. You've been listening to Environmental Health Chat, brought to you by the Global Environmental Health program at the National Institute of Environmental Health Sciences.