

## IMPACTS OF DEFORESTATION ON THE INCIDENCE OF DISEASES IN THE BRAZILIAN AMAZON

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The lack of knowledge about the effects of deforestation on human health is one of the most crucial gaps in the management of natural capital, making it difficult to design effective public policies for the environment and for health. This is especially true in northern Brazil, a region where most of the deforestation in the country occurs, and whose social vulnerability can amplify the effect of environmental imbalances. Better information about the relationship between deforestation and disease can therefore identify the costs that have been neglected in environmental valuation efforts and facilitate the integration of environmental and health policies.

First we survey the academic literature. A number of studies demonstrate that environmental imbalances, especially those related to deforestation, may increase the incidence of diseases. Although there is strong evidence of this relationship in the case of malaria, the evidence is not so clear for other types of diseases. Overall, the studies largely use different methodological approaches, as well as spatial and temporal scales, which hinder the comparability of results.

This paper analyzes the relationship between deforestation in the Amazon and a set of nationally notifiable diseases from the Brazilian Unified Health System (Sistema Único de Saúde - SUS). We use data on the incidence of diseases of compulsory reporting from the Notifiable Diseases Information System (Sinan) dataset from the Ministry of Health, and deforestation data from the Project for Monitoring Amazon Deforestation (PRODES) from the National Institute for Space Research (INPE).

Using Poisson count data models, we evaluate the impact of deforestation on notifiable diseases

in 773 municipalities in the Amazon between 2004 and 2012. The diseases that provided sufficient observations for analysis were dengue, Chagas' disease, schistosomiasis, typhoid fever, leishmaniasis cutaneous, visceral leishmaniasis, leptospirosis, malaria and measles/rubella. To our knowledge, no other study uses such a long time series across a large geographic area for such a wide range of diseases.

For each disease we estimate regressions with municipality fixed effects and time-varying controls for climate, socioeconomic and public health characteristics of each municipality. We include all 773 municipalities of the Brazilian Legal Amazon, and can therefore control for unobserved effects at the municipal level over an extensive area and with a more granular level of geographic detail compared to existing studies. This municipal-level analysis facilitates the use of the findings of this study by environmental and health policymakers, who generally take action at the local municipal level. The time interval used is one in which data on deforestation and diseases in Brazil are more accurate and complete. The relatively long period of observation enables us to control for long-term trends and increases the accuracy of the estimates.

The results indicate that deforestation indeed affects some diseases and therefore has an impact on public health; however, unlike other authors, we did not find a generalizable effect on disease as a whole. Our study finds clear effects of deforestation only on the incidence of leishmaniasis and malaria. The estimates indicate that an increase of 1% in the deforested area leads to a 23% increase in cases of malaria and 8% to 9% in cases of leishmaniasis.

The study therefore documents the existence of unaccounted costs of Amazon deforestation due to the increased incidence of some diseases. These costs should be taken into account both in the provision of public health and in decision-making regarding natural capital. It is clear that there are synergies between policies to control malaria and leishmaniasis and policies to prevent deforestation in the Amazon. Efforts to prevent and treat diseases can thus occur jointly with environmental enforcement, while taking into account the spatial distribution of deforestation and its evolution. Moreover, valuation models used to assess the environmental impacts of projects and their mitigation should include the impact of deforestation on malaria and leishmaniasis as another variable in the social costs of such projects.

## EXECUTIVE SUMMARY

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