“Fishbone” Deforestation in Rondônia, Brazil: Trends and Projections

Yosefa Allegra Ehrlich
Tufts
Remote Sensing
Spring, 2010
USGS Earth Explorer

Rondônia and Deforestation

The state of Rondônia occupies 243,044 km^2 in the north-west pocket of Brazil and originally housed 208,000 km^2 of closed canopy rain forest. However, in the early 1970s the Brazilian government launched a series of rural development projects that initiated a trend of severe deforestation in what are known as “fishbone” patterns (Pedlowski, Dale, Matri-cardi et. al., 1997; Milikan, 1992; Biello, 2010). This unique fishbone shape is a result of deforestation occurring along a network of rapidly expanding roads.


Rondônia, Brazil (red)


Hyacinth Macaw, an Amazonian endangered species

Deforestation is associated with a host of biological disturbances including decreased biodiversity and modified climate patterns (Skole, 1993). Given that the Amazon is the largest continuous region of tropical rainforest in the world, housing nearly 50% of the world’s plant and animal species, disturbances must be taken seriously.

The Fishbone Paradox


A typical “fishbone” pattern

Recent studies have shown that “fishbone” deforestation may have a different set of environmental outcomes. Creating isolated segments of deforested area may, in fact, increase precipitation. Deforested patches are warmer than forested land, which creates localized low-pressure zones. When cool air rushes to fill the void, the convergence causes rain clouds to accumulate. Thus, paradoxically, deforested patches increase rainfall and in turn the rate of potential vegetative recovery (Biello, 2010).

Isolated Segment Deforestation

Speedy Vegetative Recovery — **Increased Precipitation**

Purpose of Study

This study assessed the rate of vegetative change in a pilot region of Rondônia, from 1986-2008 to determine the severity of vegetation loss in “fishboned” regions. Future projections of loss were estimated based on the observed rates of change to determine whether “fishbone” patterns indeed slowed deforestation in this sample. Importantly, the results of this sample are not indicative of the entire region’s deforestation and re-growth patterns but rather reflect an emerging trend.

References:

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Skole, D., Tucker, C. “Tropical Deforestation and Habitat Fragmentation in the Amazon: Satellite Data from 1978 to 1988.” *Science* 260.5116 (1993): 1905-1910. Web. 26 Apr. 2010.

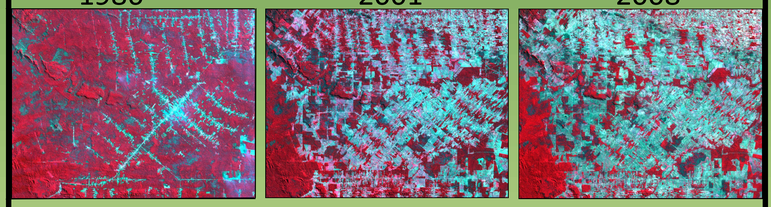
Pedlowski, M. A., Dale, V. H., Matricardi, E. A. T., & da Silva Filho, E. P. “Patterns and impacts of deforestation in Rondônia, Brazil.” *Landscape and Urban Planning* 38.4-5 (1997): 149-157. Web. 26 Apr. 2010.

Acknowledgements:
Eman Ghoneim; Simcha Levental; Tufts GIS lab; Tufts Environmental Studies Department.

Methods

Study Area: Rondônia, Brazil; Latitude –11.6, longitude –62.4; Clipped to 2,953 km^2.
Images from USGS Earth Explorer; Landsat TM 4-5; Bands 1-5 and 7.
Image Dates: August 1986; August 2001; August 2008.

Original Images (vegetation represented in red)

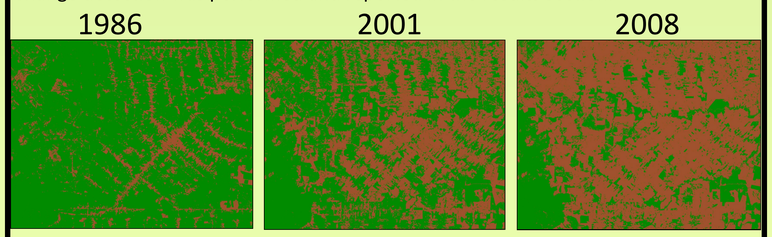


NDVI (vegetation represented in white)

Normalized Difference Vegetation Index estimates the total amount of vegetative cover in an image. The vegetation was highlighted in brighter colors as a result of a ratio that compared bands with high contrast. Green vegetation is most absorbed in the red band and most reflected in near infrared.

Classifying the Density Slice (vegetation represented in green)

The image samples were classified into two categories: vegetated and non-vegetated. Vegetation was colored green and non-vegetated land was colored brown. ROIs were then generated to determine accuracy. Confusion matrixes indicated that accuracy was 100%, 99.7% and 99.% for 1986, 2001 and 2008 images respectively. Change detection was performed and reported in the results section.

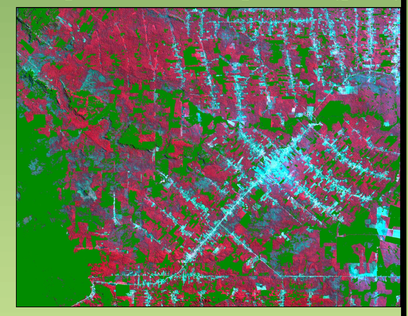


Results

Vegetation Remaining in 2001 (green)

Change detection analysis indicated that between 1986 and 2001, **781 km^2** of vegetated land were lost. This represents a **30%** decrease in vegetative land from 1986 (2,178 km^2). Loss occurred at an annual rate of **2%** over this 15 year span. The image on the right is the original 1986 area in false color overlaid with the vegetation (green) remaining in 2001.

Vegetation Remaining in 2008 (green)



Change detection analysis indicated that between 2001 and 2008, **653 km^2** of vegetated land were lost. This represents a **25%** decrease in vegetative land from 2001 (1,396 km^2). Loss occurred at an annual rate of **3.6%** over this 7 year span. The image on the left is the original 1986 area overlaid with the vegetation (green) remaining in 2008.

There was a total loss of **1,433 km^2** between 1986 and 2008, representing a **66%** decrease in vegetative land over a 22 year span.

Fig. 1: Vegetation in area and rate of loss for three study years and projections

Year	km^2 Vegetation Remaining	km^2 Vegetation Lost	% Rate of Loss / Year
1986	2,178	--------	--------
2001	1,396	781	2%
2008	744	652	3.6%
2013	163	581	6.4%

The future annual rate of loss was projected to be **6.4%** based on average annual rates of loss observed across the study samples. At this rate, by 2013 the amount of vegetated land remaining would decrease by **581 km^2**. If this rate is accurate, only 163 km^2 or 7% of the original vegetated land will remain representing a **total loss of 93%** across 27 years.

Conclusions and Recommendations

In this study sample the rate of deforestation increased between 1986 and 2008 at an exponential rate. Seeing as 66% of the original vegetated land in this sample became deforested in 22 years, the apparent benefits of the “fishbone” pattern are not evident. Thus, deforestation is responsible for negative environmental outcomes regardless of its “fishbone” nature.

To avoid reaching 93% deforestation by 2013, the Brazilian government should issue protective legislation, initiate rainforest rehabilitation programs or create incentives for businesses and communities to relocate from Rondônia to mitigate the effects.