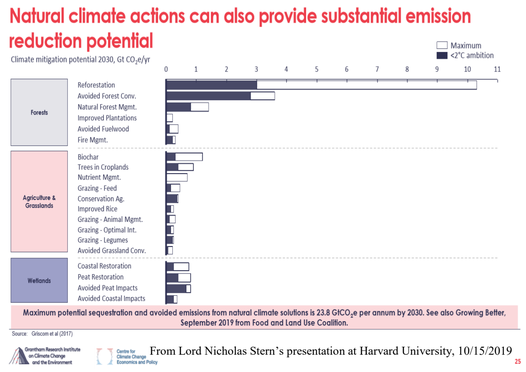
FALL OF THE AMAZON RAINFOREST

WHO IS SUPPORTTING REFORESTATION IN BRAZIL?

INTRODUCTION

Brazil has been a leader in global efforts for battling negative climate impacts until Jair Bolsonaro, a far-right President, whose presidential term started on January 1, 2019. Climate scientists and environmental organizations around the world have placed a great deal of importance on Brazil's rainforests since reforestation, amongst other natural options, has the greatest potential for reducing carbon dioxide emissions.

Unfortunately, President Bolsonaro has been implementing policies that are exposing the Amazon rainforest to more logging, large-scale mining, and industrial agriculture. Consequently, the deforestation rate in the Brazilian Amazon has surged more than 30 percent just over the past year according to official data published by Brazil's National Space Research Institute (INPE). INPE's report also emphasized a dramatic jump in the frequency and scale of wildfires raging in the Amazon rainforest; 72,843 wildfires detected as of August 21, 2019, indicating an 83% increase from the same period in 2018. Unfortunately, more wildfires are expected in the Amazon since fire is one of the most common methods for cutting down trees in Brazil. Since taking office, President Bolsonaro has eliminated 95% of the Ministry of Environment's budget allotted for climate change activities, transferred the body responsible for certifying indigenous territory from National Indian Foundation to the Ministry of Agriculture, converted environmental fines into alternative compensations, and lastly, changed the Forest Code to extend deadlines for enforcement measures. These are political factors that have been and will continue to exacerbate deforestation in Brazil's rainforests.



Fortunately, according to Reuter's report, the representatives of Brazil's 12 state (federative units) governments were reported to have gathered and jointly committed to upholding the country's previously submitted national commitment in the Paris Agreement to cut greenhouse gas emissions back in April this year (list of the 12 states was not available).

Deriving from the framework of Shrestha's work in looking at the socioeconomic factors as drivers of tree cover change in Nepal (population, human development index, rate of primary education) this project will attempt to answer the following questions:

<Research Questions>

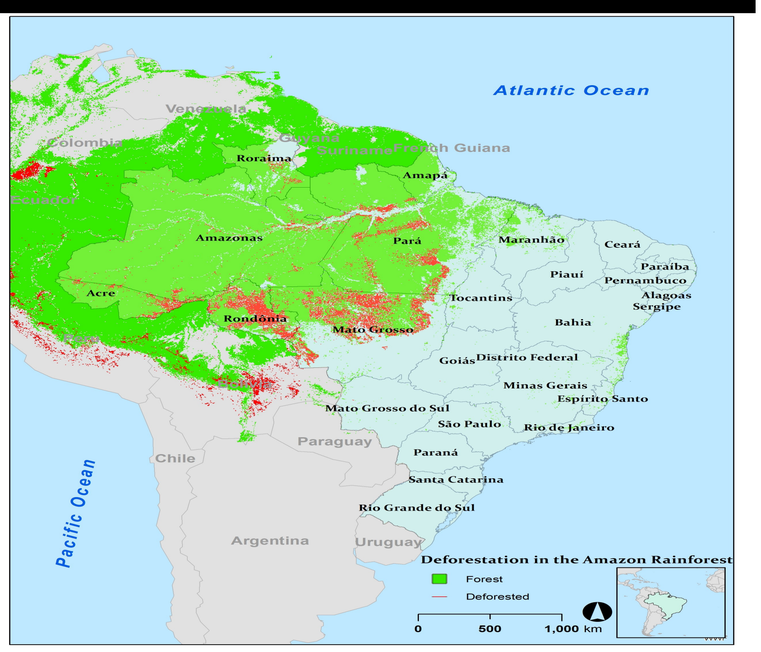
1. Which states are affected by deforestation?

2. Based on the following socioeconomic factors—population, human development index, and rate of primary education, which states are likely to support reforestation policies?

(Which would naturally identify the 12 states that have committed to upholding Brazil's efforts in cutting greenhouse gas emissions in accordance with the Paris Agreement)

3. How likely are the deforested states to support reforestation policies?

Brazil's Deforestation 2008~2019



METHODOLOGY

Step 1. Deforestation Magnitude 2008~2019

The deforestation magnitude or rate was gathered from TerraBrasilis, which is a platform built by INPE for the utilization of geographic and environmental data. The raster format of the data seemed to be effective in representing which areas or regions have experienced deforestation in a visually elaborate way. Raster reclassify was used to differentiate the areas that are affected by deforestation and those that are not. The data were reclassified into two values: 1 indicating deforested areas and 0 being irrelevant. Because the deforestation data is raster, zonal statistics as table operation was used to calculate the area of deforestation by state. The zonal statistics as table step was crucial in joining the information discovered in the deforestation data (raster) to the state-level socioeconomic factor data (vector) through the state-level data's attribute table. Finally, the combination of select by attribute for area and field calculator was used in the zonal statistics table to assign lowest (unaffected or affected the least) deforested areas (smaller areas) a score of 1 and the largest areas a score 4 (most affected).

Socioeconomic Factors Scores -Combined

Brazil's Population and Score by State, 2019

Brazil's HDI Score by State, 2010

Brazil's Primary Education Rate by State, 2015

Step 2. State-level Socioeconomic Data

Shrestha's work argues that various socioeconomic factors such as population, income, urbanization, education, and human development index (HDI) are likely and strong drivers for reforestation in Nepal. Based on Shrestha's framework, three socioeconomic factors– population, education, and HDI are used in the process of identifying which states would and how likely they are to support reforestation policies.

Population

Because Brazil is still a developing country, a state population is an important indicator of urbanization. There are 27 states, or federative units, in Brazil. Based on the Brazilian Institute of Geography and Statistics (IBGE), federative units with a population below 1 million were assigned a population score of 1, indicating a lower level of urbanization. Conversely, federative units with more than 9.5 million people were assigned a population score of 4, indicating a high level of urbanization. The whole operation was done through select by attribute in the attribute table for precisely selecting from the data, and a field calculator was used to assign scores between 1~4 accordingly.

Human Development Index (HDI)

According to United Nations Development Programme (UNDP), "The HDI was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone." This is one of the reasons why HDI is used in Shrestha's work. The definition of HDI provided by UNDP mentions that HDI is a summary measure of average achievement in key dimensions of human development, such as a long and healthy life, being knowledgeable and having a decent standard of living; essentially a geometric mean of normalized indices for each of the three dimensions. In Brazil, the highest HDI is 0.824 in Distrito Federal, followed by 0.783 in São Paulo, with the lowest being 0.631 in Alagoas, and 0.639 in Maranhão. As a comparison, the U.S's HDI value for 2018 is 0.92 (higher the better). Federative units with an HDI below 0.665 were assigned a score of 1 and those with HDI levels above 0.74 were assigned a score of 4. The process of assigning the scores is identical to the population section above and will also be the same for the primary education rate section below.

Primary Education

Primary education is mandatory not only for continuous development but for secondary and post-secondary education as well. Educated people are more likely to be interested and aware of climate impacts, thus they will be more sensible in being supportive of reforestation and other commitments that Brazil had previously promised in Paris Agreement in 2015. Similar to population and HDI above, federative units with low primary education rates were assigned a score of 1 and those with high rates were assigned a score 4.

Combining All Scores

All the socioeconomic factors' scores were then combined in the attribute table to produce a comprehensive map showing which states are likely to support reforestation based on the three factors above. Since each factor was assigned a value between 1~4, the highest score that can be achieved for each state (federative unit) is 12.

Step 3. Combining Step 1 and 2

Since not every state (federative unit) is affected by deforestation, the data produced in steps 1 and 2 are not sufficient to answer research question 3—**How likely are the deforested states to support reforestation policies?** The geospatial analysis from steps 1 and 2 indicates that there are 14 federative units affected by deforestation. The deforestation scores from step 1 in the raster data's zonal statistics table was joined to the state-level analysis (through joins and relates operation based on state names) , increasing the total score achievable by each state from 12 to 16 (three socioeconomic

Step 3. Continued

deforestation scores from step 1 in the raster data's zonal statistics table were joined to the state-level analysis (through joins and relates operation based on state names), increasing the total score achievable by each state from 12 to 16 (three socioeconomic factors + deforestation score). The combined data represented in vector format shows the likelihood of the 14 states (federative units) supporting reforestation based on each state's combined socioeconomic scores.

RESULTS & FINDINGS

Likelihood of Deforested States Supporting Reforestation

Interestingly, the federative units with a value of 0, indicating that these federative units are not affected by deforestation, are mostly the federative units with the highest socioeconomic scores. Historically, Brazil's drivers of deforestation were: road building, meeting energy demands, access to markets, need for space (relocation for cattle), the agriculture-industry expansion for soybean and meat, to name a few examples. In other words, there is a possibility that the 13 states that are unaffected by deforestation (dark-grey areas on the map) likely have deforested their states almost completely to engage in more economic development, which may have not been the case with the other 14 states that are simultaneously affected by deforestation and likely to support reforestation. The states that are affected by deforestation and most likely to support reforestation have the highest scores of 12, but a big portion of the score comes from a high deforestation score (low socioeconomic factor score).

The socioeconomic factors map indicates that most economically developed states are entirely located in the Southeast of Brazil (not much forest is there). Other less-developed states are located around or in the forest areas (mainly the Amazon forest). Santa Catarina may seem like an exception in that it is the only most-economically-developed-state located in the Southeast (with the combined socioeconomic factor score of 10) and very likely to support reforestation. The effect of deforestation is low for Santa Catarina as indicated by the total combined factor score of 11 (deforestation area score of 1).

<Possible list of 12 federative units from research question #2>

States with high combined score	Socioeconomic factors score / Total factors score (including deforestation scores)
Paraná	12 (unaffected by deforestation)
Rio de Janeiro	12 (unaffected by deforestation)
São Paulo	12 (unaffected by deforestation)
Minas Gerais	11 (unaffected by deforestation)
Rio Grande do Sul	11 (unaffected by deforestation)
Pará	8/12 (deforestation score of 4)
Mato Grosso	7/11 (deforestation score of 4)
Amazonas	7/11 (deforestation score of 4)
Maranhão	7/10 (deforestation score of 3)
Bahia	9/10 (deforestation score of 1)
Goiás	9/10 (deforestation score of 1)
Santa Catarina	10/11 (deforestation score of 1)

Limitations

The raster data for deforestation was very useful and appropriate, but it was difficult to manage because the data was large. Also, using more socioeconomic factors would have led to more precise and reliable results. Specific state-by-state political analysis would have helped also, but there were limits on the availability of such information. Furthermore, most of the data would be written in Portuguese, posing language barrier problems.

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Cartographer: **SangVin Chey**

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Data Sources: **UNDP, IBGE, INPE, ESRI, WorldBank, HDX**

Projection: **WGS_1984_UTM_Zone_23S**
Transverse Mercator (Meter)