Deforestation of the Amazon Rainforests and CO_2

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http://sitemaker.umich.edu/section3group2/deforestation_of_the_amazon_rainforests_and_co2

Introduction

The face of the Earth as we know it could change dramatically in the near future due to the effects of global climate change. Most scientists would agree global climate change is occurring in our present day at an alarming rate, which is a concern for the entire human population because of many possible consequences, such as an increase in extreme weather storms such as hurricanes and a loss of the polar ice caps, both leading to an increase in flooding and a possibly massive loss of land mass in highly residential coastal areas.

One of the factors adding to the warming of the earth is an increase in greenhouse gasses, such as CO_2, contributed by human practices such as the burning of fossil fuels. The canopy of the Amazon rainforest is a major player in the amount of CO_2 that is cleaned out of the atmosphere. However current anthropogenic practices, such as deforestation for farmland or wood capital, lead to a major change (i.e. decrease) in woodland in the Amazonian demographic. Not only does this lead to a decrease in habitat for tropical species, but it also reduce the amount of trees helping to rid the atmosphere of CO_2 and other greenhouse gasses. Furthermore, the practice of burning to clear woodland leads to a massive release of CO_2 into the atmosphere, as the carbon that was stored in the tree itself is discharged back into the air during combustion. Therefore, our hypothesis is that deforestation of the Amazon rainforest leads not only to a reduction of the amount of CO_2 taken out of the atmosphere, but also to an increased release of CO_2 in the atmosphere.

To investigate this hypothesis our group devised a methodical approach: First we sought to find the total area of Amazônia, the area this project concerns. Next we found the rate of deforestation in this area, which we then multiplied by the length of time it has been going on to find the total deforested area. One of the major problems of logging, even selective logging, is the fires that follow it. These fires clear the land of biomass and show up on satellite images as deforested areas (Cochrane et al., 1999; Nepstad et al., 1999b in Fearnside, 2005). For the purposes of this project we assumed that the areas of deforestation taken from satellite images that we found were burned. By multiplying the average amount of carbon released per area by the total area deforested by fire, we produced an estimate of the total carbon release due to combustion which, by the assumption that all estimates of deforestation from satellites are due to combustion, we equate with the gross carbon release by deforestation in general.

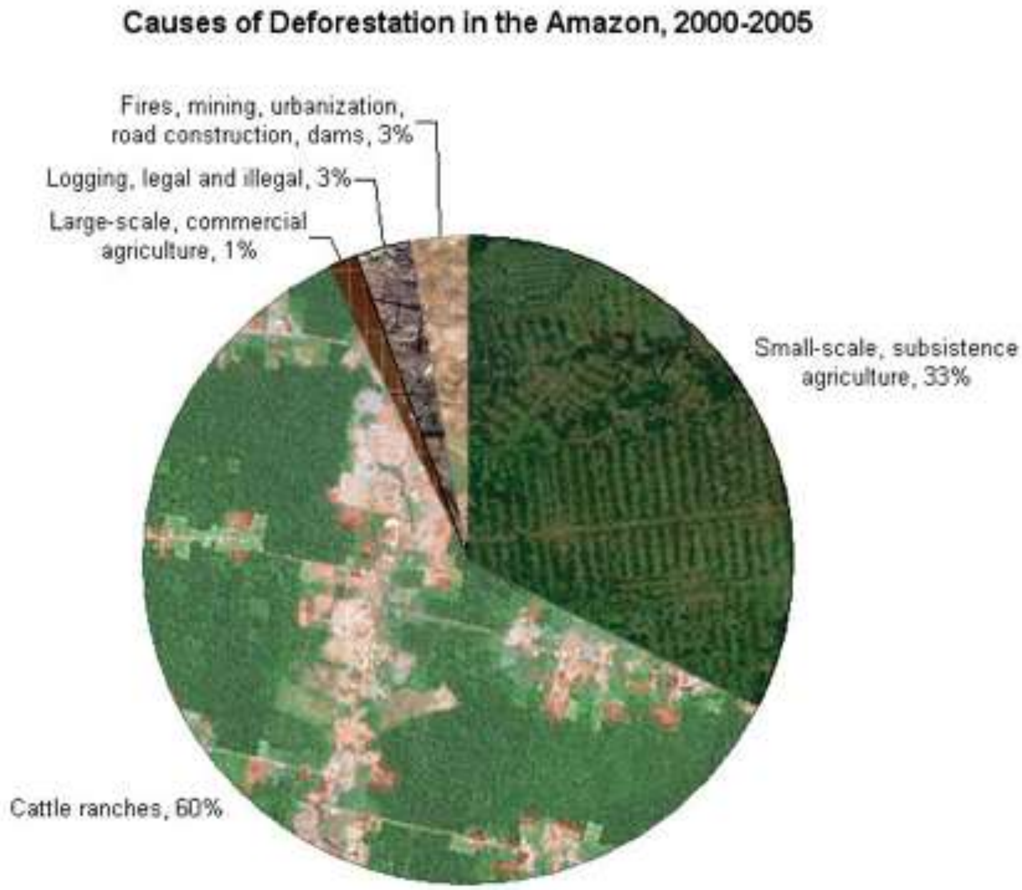
Yet the Amazon does not only release carbon into the atmosphere; as we mentioned earlier, the photosynthetic uptake of carbon provides a crucial sink for carbon absorption. We therefore found the average amount of carbon absorbed per area of rainforest per year and multiplied this by the total area minus the deforested area to produce an estimate of the total absorption of carbon by the Amazon per year. We then subtracted this total absorption from the gross carbon release to produce and estimate for the net carbon flux in the Amazon due to deforestation.

Total Area and Deforestation of the Brazilian Amazon

According to Fearnside et al. Although Europeans have been present in the Amazon for over five centuries, the assault on the Brazilian Amazon did not truly begin until the 1970's. Before 1970 a total area of 1×10^7 ha had been deforested, known as "old" deforestation (Instituto Nacional de Pesquisas Espaciais, 2004 in Fearnside, 2005). This area, about the size of Portugal, pails in comparison with the 2003 total of 648.5×10^5 ha – a staggering 16.2 % of the 4×10^8 ha originally forested Legal Amazon region (Fearnside, 2005).

Beginning in the 1970's tax incentives and government-subsidized credit at rates well below inflation became a strong driver of deforestation (Mahar, 1979 in Fearnside, 2005). Although a 1991 decree prevented new incentives, it allowed old ones to remain intact (Fearnside, 2005). This decree (no. 153) preceded most of the observed decline in deforestation since 1970 (Fearnside, 2005).

The main perpetrators of deforestation are medium to large cattle ranches, which require vast amounts of cleared land for grazing, and not small farmers who use family labor as many have insinuated. Evidence for this can been seen in the impacts of macroeconomic factors such as money availability and inflation rate on the rate of deforestation. For instance, the 1994 Plano Real reform directly preceded the largest spike in deforestation, reaching 29.1×10^5 ha in one year alone (Fearnside, 2005). Since money is required to buy machinery, chainsaws, and labor, it is expected that large-scale organizations would be more effected by swings in the economy.



Deforestation in the Amazon. (Butler, 2006)

If rates of deforestation are associated closely with the country's economy, than why were 23 x 10^5 ha of forest (up from a previous rate of 18.2 x 10^5 ha) demolished in 2002, a year with a very disappointing domestic economy? The answer is that the forces behind deforestation are becoming increasingly globalized. This has largely to do with the rapidly increasing demand for soybeans and beef, which previously had been restricted to the domestic market because of foot-and-mouth disease, in the global market (Alencar et al., 2004; Kaimowitz et al., 2004 in Fearnside, 2005). Currently the advancement of soybean plantations posses an enormous threat because of its stimulus for government investment in infrastructure like waterways, railways, and highways, which can destroy more forest than the plantations themselves (Fearnside, 2001c in Fearnside, 2005). This was further spurred by the Acanca Brasil program, a development package for 2000-2007 which included US$20 billion in infrastructure in the Amazon region (Laurance et al., 2001; Nepstad et al., 2001; Fearnside, 2002a in Fearnside, 2005), mostly driven by the perceived need to transport soybeans (Fearnside, 2005).

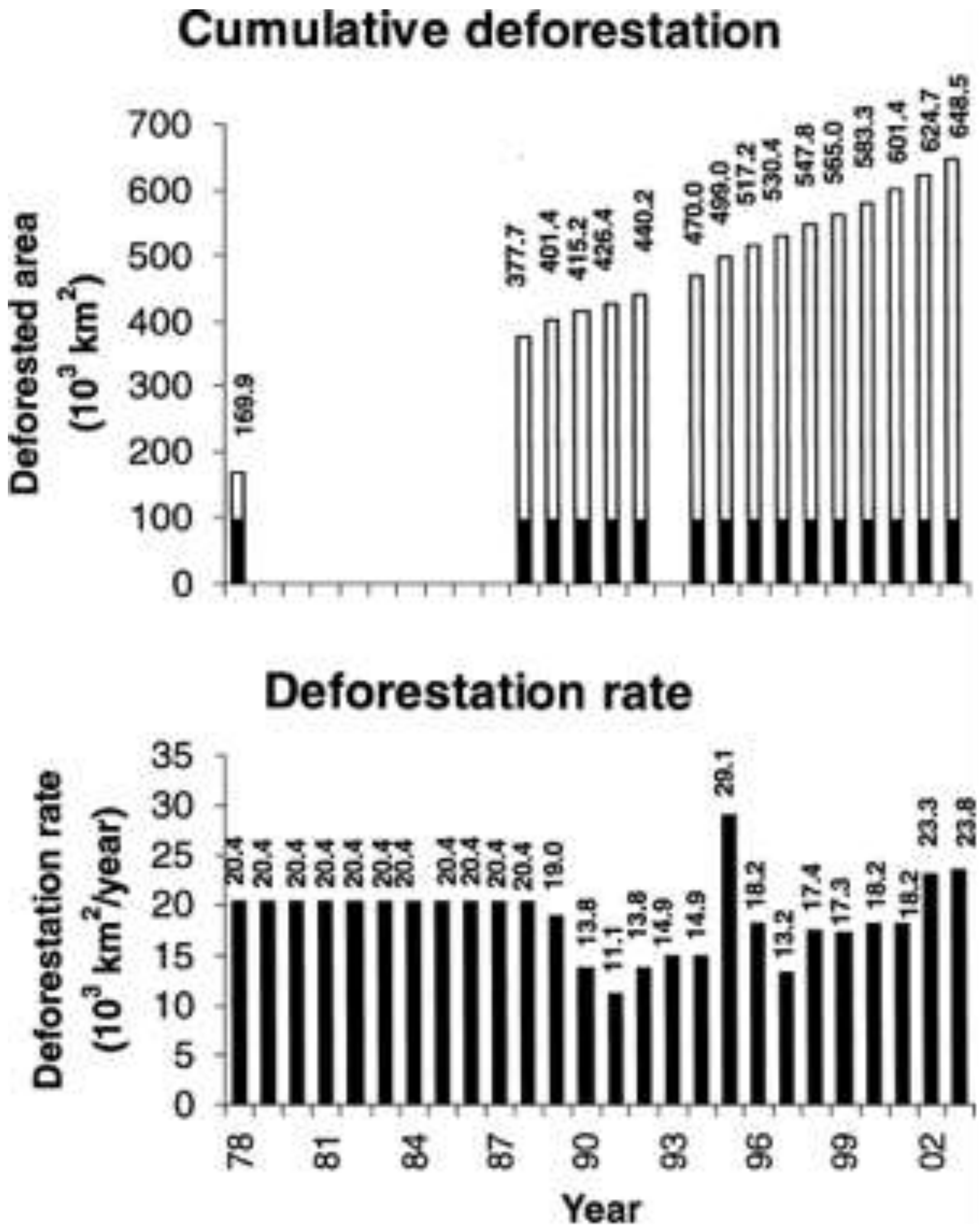
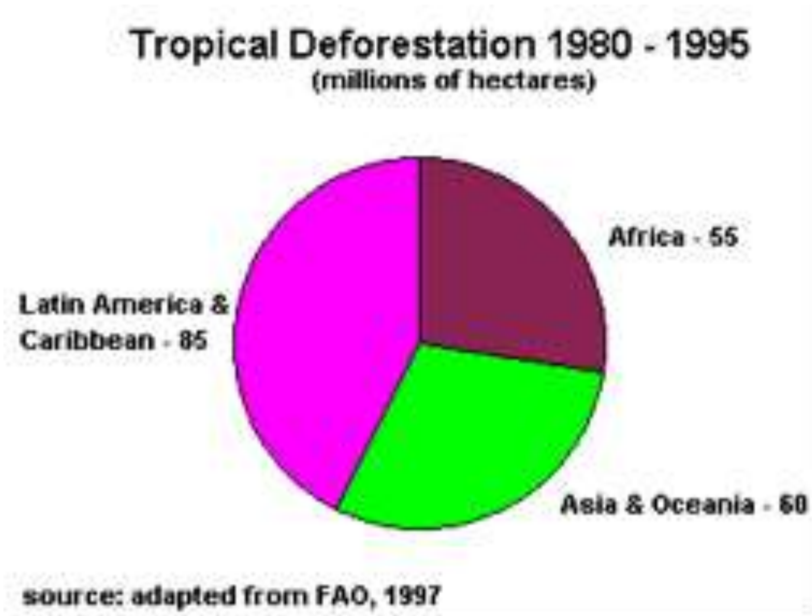


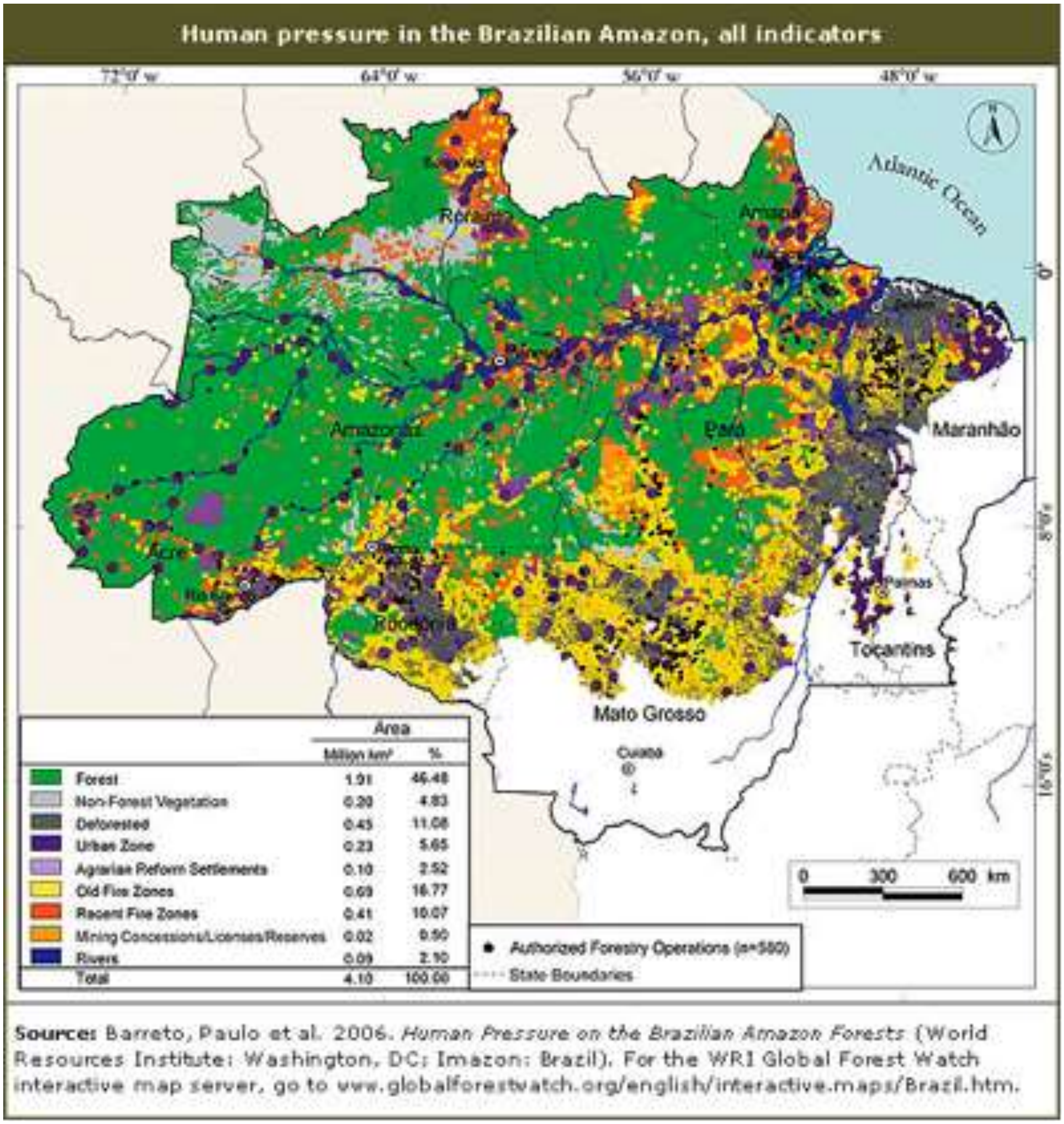
Figure 1. Deforestation in the Brazilian Amazon. . Data from INPE (2004) except for 1978 (Fearnside 1993b in Fearnside 2005). (Fearnside et al., 2005)

By averaging the rates of deforestation over the 26 years from 1978 through 2003 as given in Figure 1, we obtained an average rate of deforestation of 18.9 x 10^5 ha/yr. Although this does not perfectly represent the rate of deforestation since its acceleration in 1970, we take it as good estimate. Therefore by multiplying this rate by the length of time it has been going on (26 years), we produced an estimate of the total deforested area of the Brazilian Amazon of 491.8 x 10^5 ha/year



This graph shows us that although there is tropical deforestation in many parts of the world, the deforestation that occurs in Latin America and the Caribbean is by far at the highest rate. Eighty-five million hectares have been deforested in 15 years. (Roper, 1999)

Although loggers may not always deliberately set fire to the forest, their actions have the same end result because logging greatly increases the susceptibility of a forest to fire (Fearnside et al., 2005). The logging process "results in the damage of almost twice the volume of trees being harvested" (Verissimo et al., 1992). For instance, near Paragominas, Para, for every tree harvested, 27 trees have been reported killed or severely damaged (Verissimo et al., 1992). This increases the impact of fires in two ways: one is that the degradation of the canopy allows more sunlight and wind to reach the forest floor, resulting dryer conditions that decrease "the number of rainless days needed for the understory to reach flammable conditions" (Fearnside et al., 2005). The second way in which logging magnifies the effect of fire, even naturally occurring fire, is that the dead and damaged trees that resulted from the logging process increase the fuel load and cause larger hotter fires. These in turn further dry the understory and kill and damage more trees which leads to future fires which are "much more damaging" (Fearnside et al., 2005).



World Resources Institute Project: Global Forest Watch. (World Resources Institute, 2006)

The process of combustion, by which fuel – in this case trees and vegetation – and oxygen are converted into carbon dioxide, water, and heat, carbon is released into the atmosphere. According to Haugaasen et al. estimates that 25.5 x 10^6 g C/ha of 35.7 x10^6 g C/ha is potentially released by combustion. The remaining 10.2 x 10^6 g C/ha is not released to the atmosphere but left as soot and residue (Haugaasen et al., 2002). By multiplying the Haugaasen et al. estimate for carbon release due to combustion with our synthesized estimate of the total area of deforestation, we produced an estimate for the gross carbon release due to deforestation: 1.2530 x10^13 g C

Carbon Absorption

Yet as we previously mentioned, the Brazilian Amazon does not only release carbon; it also absorbs it. It does this by process of photosynthesis by which carbon dioxide, water, and light energy are transformed into glucose and oxygen. Ometto et al. estimates that the Amazon absorbs between 1.6 and 1.7 Pg C/year. An average of these – 1.65 Pg C/year – is used in the analysis of this report.

Net Carbon Flux due to Deforestation

As we have presented, the total area of deforestation in the Brazilian Amazon is roughly 491.8 x 10^5 ha/year (the rate of deforestation times the number of years of deforestation). According to Haugaasen et al. 25.5 x 10^6 g C/ha/year are released from combustion. Therefore, since the area of deforestation data was obtained from satellite images, and based on Fearnside et al.'s analysis of fires we assumed this area was at some point burned, we multiplied the area of deforestation by the rate of release to find a gross carbon release due to deforestation of 1.2540 x 10^{15} g C. Ometto et al. estimated the photosynthetic absorption of carbon in the Brazilian Amazon to be roughly 1.65 PgC/year. Therefore we subtracted 1.65 Pg C/year from 1.2530 x Pg C/year to calculate a net carbon flux due to deforestation in the Brazilian Amazon of 0.397 PgC/year. Further, if this land had not been deforested, not only would its carbon not have been released, but it would have absorbed carbon from the atmosphere by photosynthesis. By our calculations, if the Brazilian Amazon had suffered no deforestation our atmosphere would contain 0.397 Pg C/year + (26 years (18.9 x 10^5 ha/year (1.65 pgC/year /648.5 x 10^5 ha))) = 1.65Pg less carbon per year.

Conclusion

According to researchers like Professor George Kling, "CO_2 concentration in the atmosphere is strongly correlated with Earth's surface temperature" (Kling, 2006). This is because CO_2 acts a greenhouse gas, reflecting Earth's infrared radiation back to the surface. It should follow, therefore, that increasing the concentration of CO_2 in the atmosphere will lead to an increase in the temperature of Earth's surface. This could have number of detrimental results such as the melting of polar ice caps, the weakening or halt of the Conveyor Belt, which carries nutrients and heat throughout the world, and raising in sea levels which could ultimately the loss of many coastal areas such as Southern Florida (Kling, 2006). According to our research, anthropogenic releases of carbon such as the deforestation of the Brazilian Amazon contribute to the rising concentration of CO_2 in the atmosphere. Our calculations suggest that deforestation of the Brazilian Amazon accounts for 0.397 Pg annually, an increase of only 0.0529% of the 750 x Pg C in currently in that atmosphere. We found that the deforestation of the Brazilian Amazon is a surprisingly small contributor to the amount of carbon in the atmosphere.

However, our research is quite elementary and possesses a variety of questions, limitations, and gaps. For one thing, it is not clear that all of the deforested land shown by satellites has been burned. We assumed that it had, which could have altered our estimation of the gross and net carbon release from deforestation. Another fundamentally crippling aspect of our research is the general discrepancy in measurements that exists in this field. The estimates for photosynthetic absorption of carbon and release due to combustion are only one group of researchers' findings. Virtually everyone who studies this issue's findings vary at least slightly. This is due to the sheer vastness of the topic and myriad of complications it encompasses. Teams also employ differing methods of measuring carbon release, carbon absorption, and even deforestation. This research project should be interpreted as one narrow scenario for deforestation's interaction with the atmosphere in regards to carbon.

Our stella model is located at http://sitemaker.umich.edu/section3group2/stella_model

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