

The Effects of Deforestation on Yellow Fever Virus Transmission

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INTRODUCTION

Deforestation is one of the leading causes of increased viral transmission in forest climates. In South America, deforestation in the Amazon rainforest has led to increased interactions between malaria-carrying mosquitoes and humans (Vittor 2020). Similarly, in Africa, Ebola outbreaks in 2004 and 2014 have been linked to deforestation and forest fragmentation (Vittor 2020). Yellow Fever, a single stranded positive sense RNA virus, infection rates are suspected to be significantly higher in areas of increased deforestation, such as South America and Africa. Mosquitoes are the primary vector of the virus, transmitting to primate and non-primate (human) hosts. Different temperature and precipitation amounts, especially when in areas of increased deforestation, may also affect transmission. Besides climate factors, population density and economic indicators, such as GDP, may influence transmission. This study analyzes how the amount of deforestation occurring in a country relates to the climatological and socio-economic factors of Yellow Fever virus transmission.

METHODS

This study was carried out in a series of 3 main steps.

- (1) Data was acquired from various publicly-available databases:
 - a. The Global Forest Watch provided data on deforestation in countries in Africa and South America.
 - b. The World Health Organization provided data on Yellow Fever cases.
 - c. World Bank data provided population, temperature, and precipitation median values over the time period.
- (2) Statistical analysis was performed in the R Programming Environment (R Core Team 2021).
 - a. Primary forest deforestation loss and tree cover extent data were analyzed for both Africa and South America.
 - b. The five countries with the highest proportion of deforestation and the five countries with the lowest proportion of deforestation on each landmass were analyzed.
 - c. Spearman's correlation tests were performed between deforestation and time for Africa and South America.
- (3) Spatial analysis was performed in qGIS.
 - a. The Africa and South America layers were joined to the excel data table and were depicted with graduated symbols.
 - b. Descriptive statistics were performed to determine averages of deforestation and Yellow Fever cases.

RESULTS

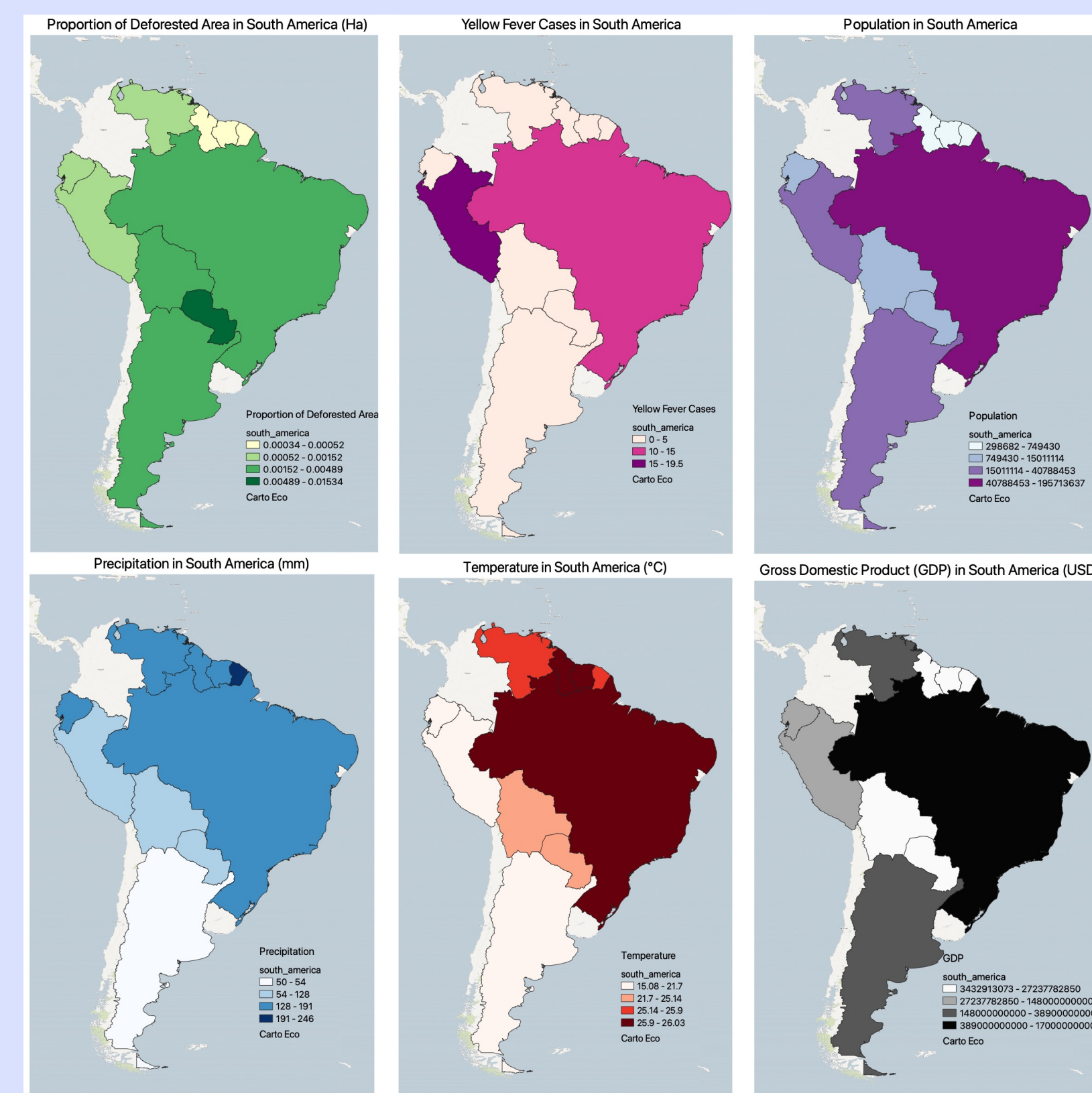


Figure 1. The South American countries of Argentina, Bolivia, Brazil, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname, and Venezuela visualizing proportion of deforestation, yellow fever cases, population, precipitation, temperature and GDP. The average proportion of deforested area in a country in South America was 0.003218 with an average of 3.65 Yellow Fever cases.

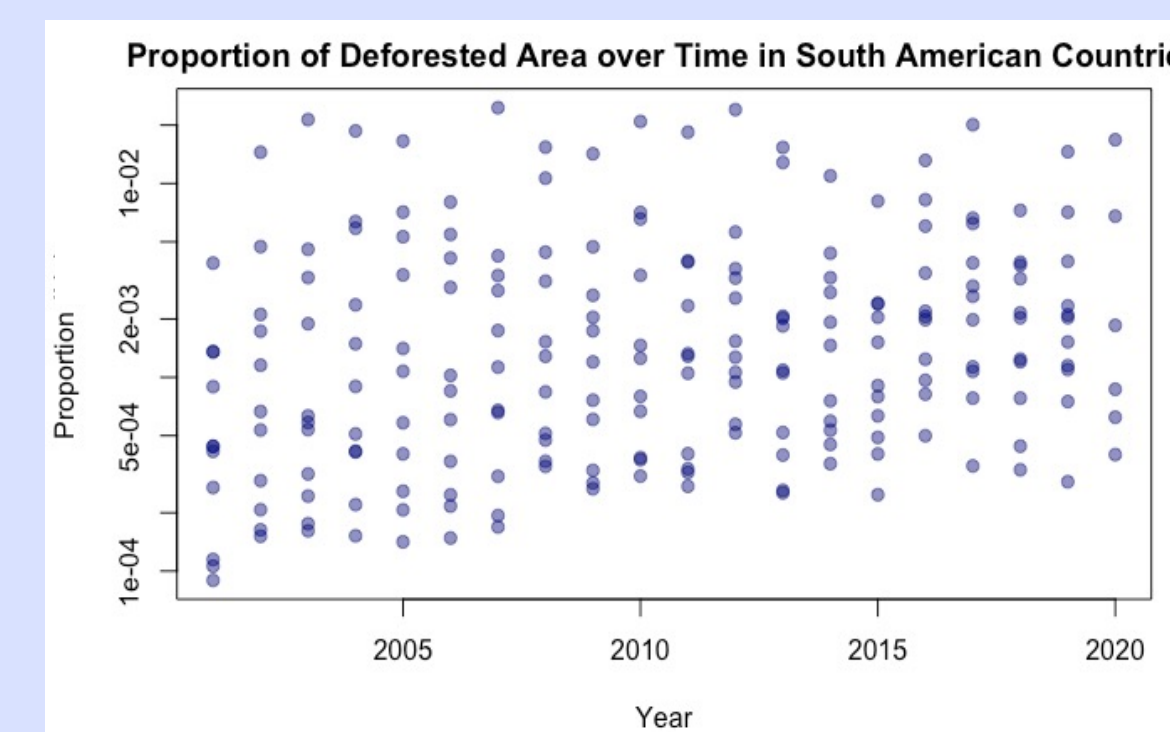


Figure 2. Change in tree cover loss over time in South America. There is a weak correlation between deforestation and time ($p = 0.24$, $p = 0.0003$).

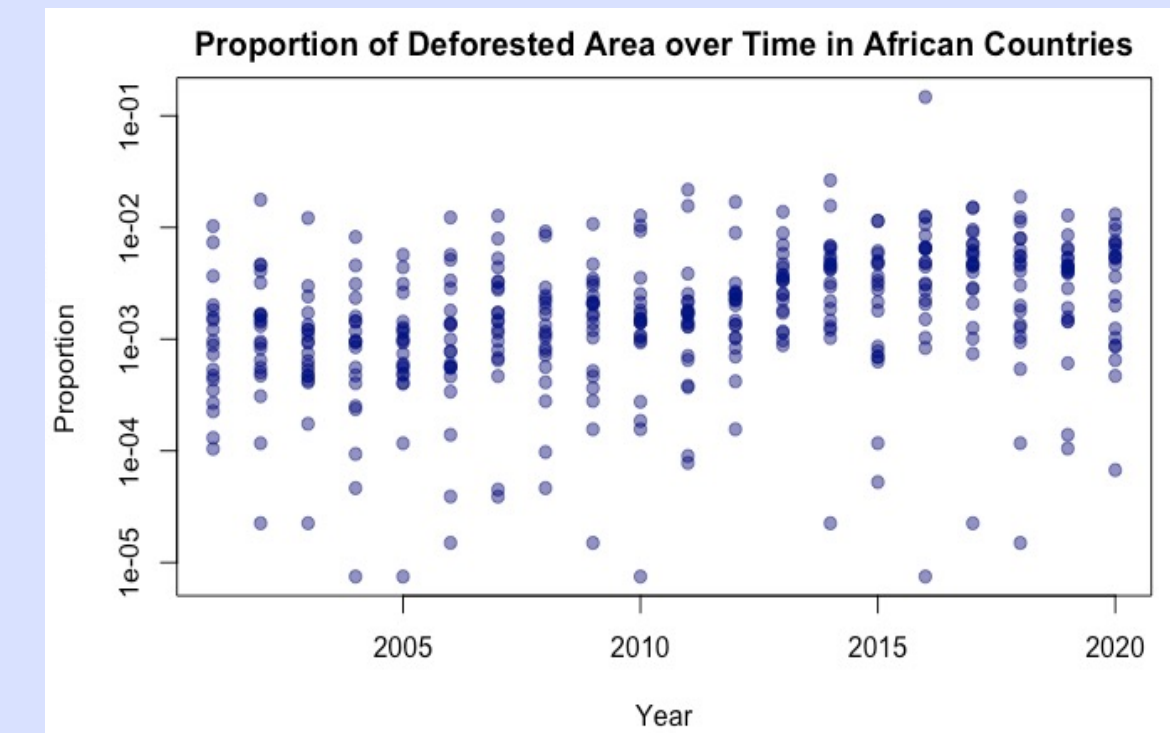


Figure 3. Change in tree cover loss over time in Africa. There is a moderate positive correlation between deforestation and time ($p = 0.41$, $p < 0.0001$).

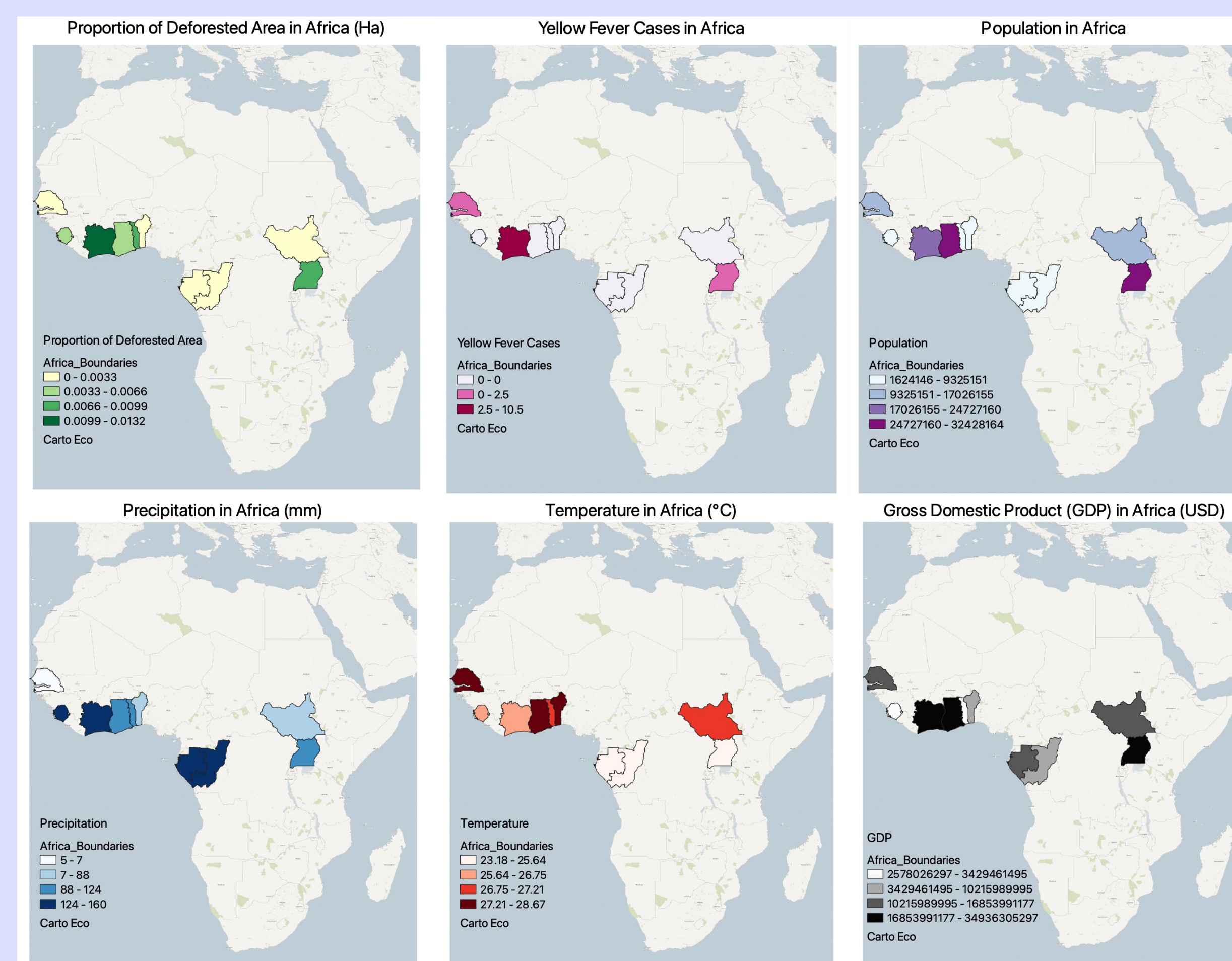


Figure 4. The African countries of Benin, Gabon, Ghana, Ivory Coast, Republic of Congo, Senegal, Sierra Leone, South Sudan, Togo, and Uganda visualizing proportion of deforestation, yellow fever cases, population, precipitation, temperature and GDP. The average proportion of deforested area in a country in Africa was 0.004347 with an average of 1.4 Yellow Fever cases.

CONCLUSION

- I. Deforestation over time has generally increased as shown by Figures 2 and 3, leading to various conclusions about other climatological and socio-economic factors.
 - a. The South American country with the most deforestation by proportion was Paraguay. Paraguay did not display high levels of many of other factors (Fig. 1), but the increase in deforestation may have a lot to do with the type of landscapes located there. The Gran Chaco Plain is the second largest forest in South America, behind the Amazon in Brazil (Voiland 2018). This sparsely populated area stretches across Paraguay, Bolivia and parts of Argentina. Bolivia and Argentina both also displayed relatively higher amounts of deforestation.
 - b. The African country with the most deforestation by proportion was Ivory Coast. Ivory Coast also displayed the highest amount of Yellow Fever cases, along with high quantities of precipitation and population (Fig. 4). The Ivory Coast is known to be one of the biggest producers of cocoa in the world (Pearce 2019), which would explain why Ivory Coast also displays such a high GDP compared to other countries of increased deforestation around it. Ivory Coast did also display a high number of Yellow Fever cases.
 - c. To combat increasing Yellow Fever cases, countries around the globe need to work together to maintain lower levels of deforestation while maintaining prevention methods to help aid in the spread anywhere.
- II. Limitations to this study include:
 - a. The scale of measurement for Yellow Fever cases could only be collected to the country level. All other data could be collected at a smaller scale, such as city. Being able to collect all the data to a smaller scale could lead to less uncertainty in conclusions.
 - b. Further limitations also arose when collecting data on the South American territory French Guiana, also known as Guyane, due to it being a French territory. Median GDP and population data were unavailable for the desired time period, so the most recent statistics were used.
- III. Future research
 - a. Every country in Africa and South America could be studied, not just the ones with the highest and lowest rates of deforestation. Once this data is acquired, valid conclusions regarding public health implications could be made to successfully combat Yellow Fever transmission and spread.
 - b. This study could also serve as a model for future studies on various other viruses.

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