How to Diagnose Anthracnose:

An Anthracnose Risk Assessment of Costa Rican Coffee Farms

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Projection: Ocotepeque 1935—Costa Rica Norte

INTRODUCTION

Arabica coffee (*Coffea Arabica*) plays a key role in the economy of Costa Rica: in addition generating income by exporting the coffee itself, these farms have also become a popular tourist destination in a country for which the tourism economy is vital. The majority of this coffee is grown on small farms called *fincas*, and in 2014 these farms covered an area of 84, 133 hectares.

Costa Rica experiences well-defined rainy and dry seasons, with rainy seasons lasting up to 7 months. This moist, tropical climate is highly conducive to anthracnose development. Anthracnose is a fungal infection typically caused by fungi in the *Colletotrichum gloeosporioides* complex. These infections attack branches, leaves, and berries, causing branch blackening and death. Excessive infection can reduce a farmer's coffee yield and, by extension, income.

Anthracnose infections do best in high-moisture environments, which can be caused by low levels of evapotranspiration, low levels of sunlight, high precipitation, and fogs that roll in if a farm is close enough to a stream or river. However, the fungus less common at high altitudes than in low-lying regions, and most coffee farms are at high altitudes where Arabica coffee does best. This project aims to combine these variables and determine which parts of the country face a greater or lesser risk or infection.

Fungicides are not completely reliable when it comes to preventing anthracnose: depending on the climate, they may or may not be effective. Branch pruning is among the most effective prevention methods, as it stops the infection from spreading, but pruning is very labor-intensive. A study by McKay et al. 2014 states that farmers are unlikely to use pruning without concrete knowledge of the threat that anthracnose poses. In creating an anthracnose risk index for Costa Rica and identifying the risk levels in significant coffee-growing regions, this project aims to create a visual tool which farmers can use to gauge their risk of infection and aid in their decision whether or not to prune.

Left Image: Healthy coffee berries before harvest. No visible symptoms of anthracnose infection.

Right Image: Coffee berries infected with anthracnose. Infected berries are black and shriveled. Healthy berries in this image are lighter in color than the berries in the left image because they're not yet ripe.

METHODOLOGY

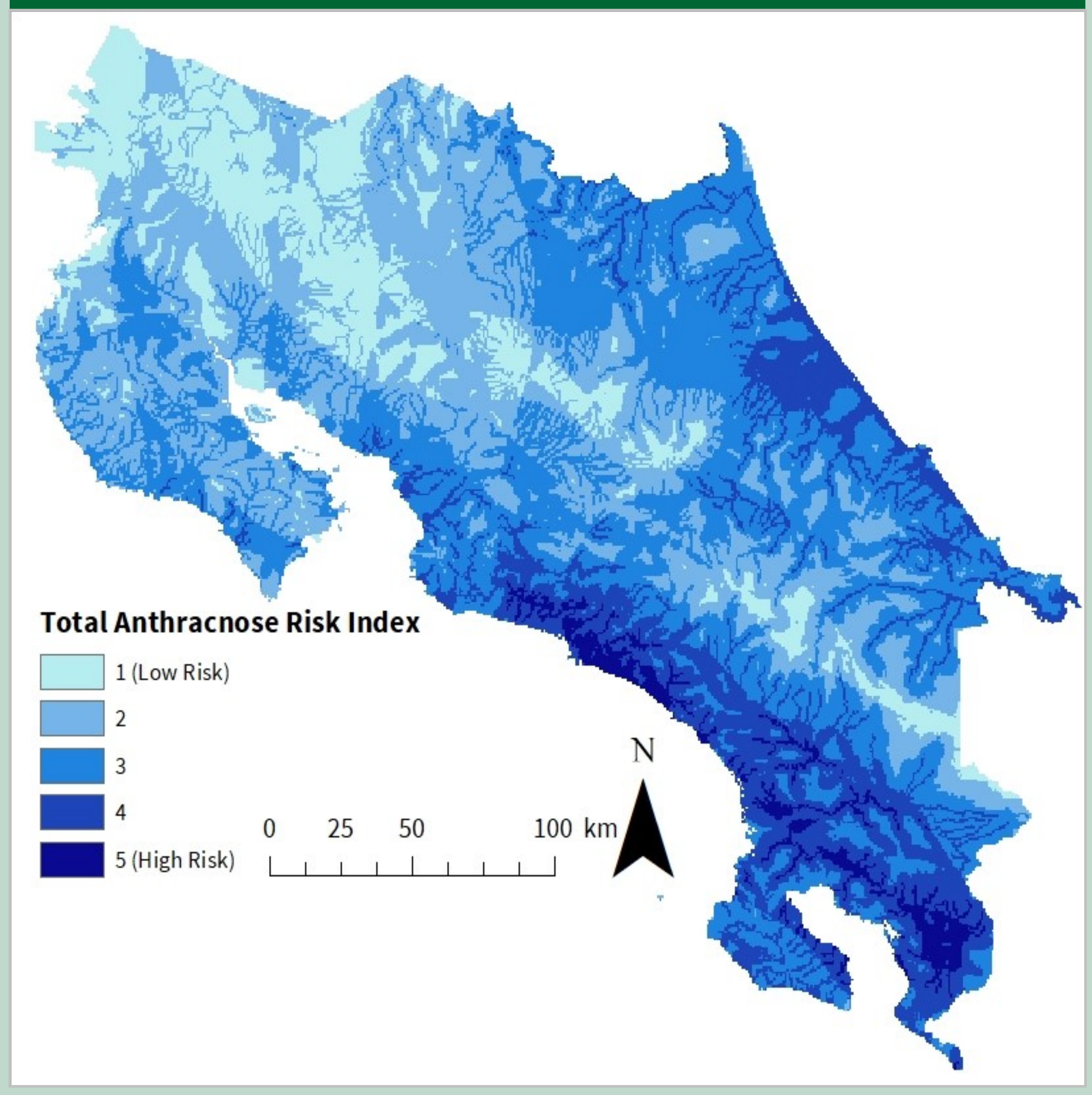
The environmental factors which have the most significant impact on anthracnose incidence are identified through peer reviewed literature. Five environmental factors were chosen for this analysis and included in the final risk index. Each factor layer was converted to a raster and reclassified on a scale from 1 (low risk) to 5 (high risk). The reclassification criteria are identified in Table 1. Raster calculator was used to perform the risk analysis, and each map was given equal weight.

The kriging interpolation method was used to apply evapotranspiration, cloud coverage, and precipitation data to the entirety of Costa Rica. To determine stream proximity risk, the Euclidean distance tool was used to classify different distances relative to the streams. The altitude risk levels were defined based on 5 different ecosystems within Costa Rica.

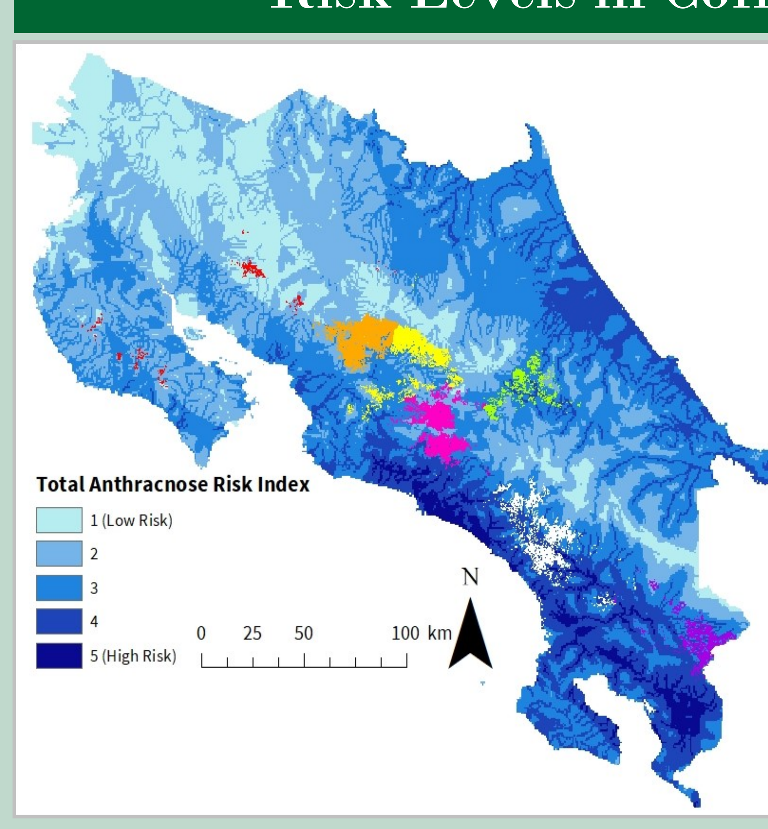
A Zonal Statistics Table was generated comparing the total risk index and the 7 different coffee-growing regions in Costa Rica. The mean value in each region is the average risk of anthracnose that coffee plants face in each region based on the total risk index generated here.

Classification	Total Annual Precipitation (mm)	Total Annual Evapotranspiration (mm)	Altitude (m)	Average Monthly Cloud Coverage (% of bright sunshine hours)	Proximity to Rivers (m from water)
1 (Lowest Risk)	0—1,881mm	1,307.01—1,401mm	2,650.01—3.852m	58.01—63%	>10,000m
2	1,881.01—2,259	1,216.01—1,307	1,500.01—2,650	54.01—58	5,001—10,000
3	2,259.01—2,653	1,130.1—1,216	500.01—1,500	50.01—54	2,001—5,000
4	2,653.01—3,127	1,054.01—1,130	100.01—500	46.01—50	501—2,000
5 (Highest Risk)	3,127.01—3,645	974—1,054	-276—100	41-46	0—500

Anthracnose Risk Index



Risk Levels in Coffee-Growing Regions



Region	Area (km²)	Mean Risk ± SD
Zona Norte	244.3 km²	1.80 ± 0.48
Valle Occidental	3,330.8	2.16 ± 0.46
Valle Central	2,206.9	2.41 ± 0.56
Turrialba	928.3	3.04 ± 0.36
Pérez Zeledón	3,338.8	2.98 ± 0.61
Los Santos	1,954.5	3.50 ± 0.52
Coto Brus	1,278.6	3.20 ± 0.46

CONCLUSION

The final risk index showed a general trend of increasing risk moving from the northern to southern end of the country. There was also a strong variation in risk depending on region: on average, a farmer from Zona Norte faces less anthracnose risk than one from Turrialba, and so they may not be as inclined to dedicate money and labor to preventative measures. The relatively large standard deviation values within each region indicate a substantial range in risk levels within in each region. At the end of the day, while this analysis could give farmers a general idea of the anthracnose risk that the environment may pose, it is no substitute for their own understanding of and familiarity with their farms.

There are several limitations to this analysis. None of the 5 environmental factors included in this analysis exist in a vacuum; that is to say, they all interact and influence one another in complex ways that are not fully understood. The weights of all the variables were made equal because, while this may not reflect the real world scenario, there is not enough information in the literature to estimate the significance of all these variables in relation to one another. In addition, three of the five maps that went into the final risk index were created via interpolation; while kriging was identified as the method which would generate the most accurate model of the systems in question, there is no guarantee that it is completely accurate.

Data Sources: Harvard Geodata, Instituo del Café de Costa Rica, ESRI

Photo Sources: Photo of healthy berries is my own. Photo of infected berries courtesy of Hawaii Coffee Ed.

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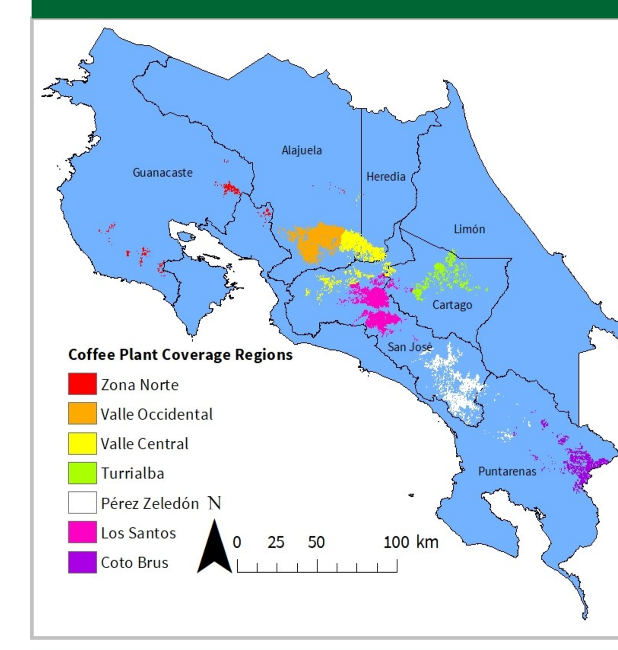
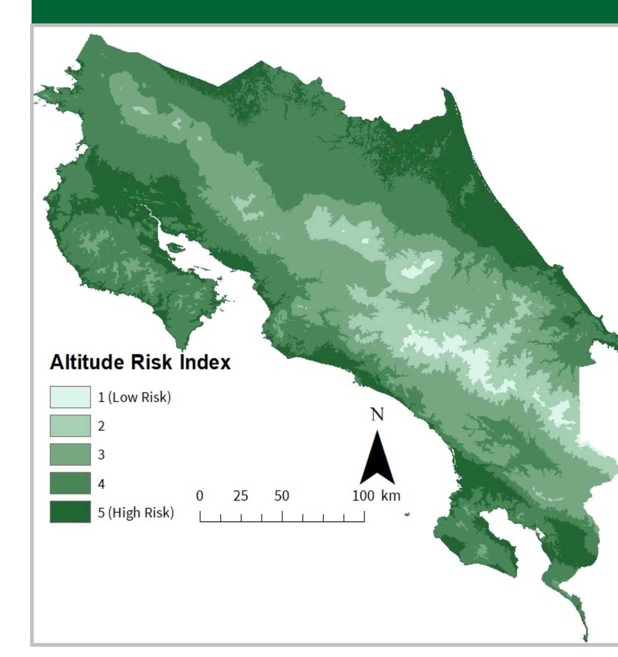
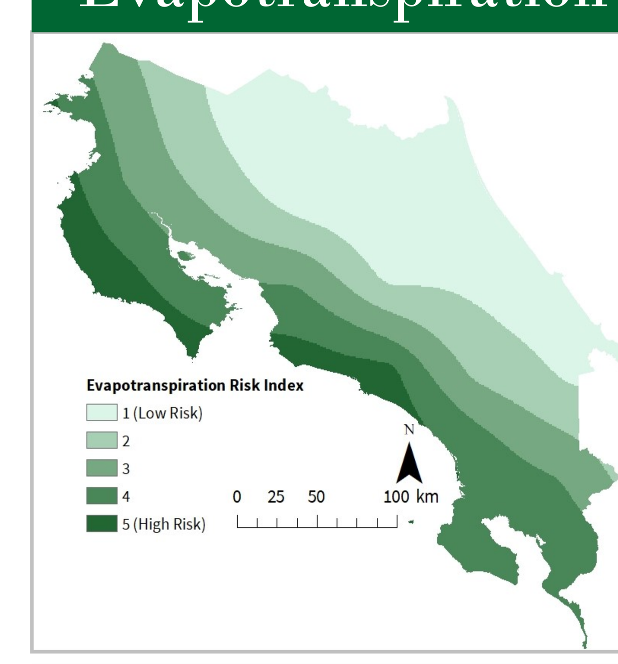
Coffee Growth Sites



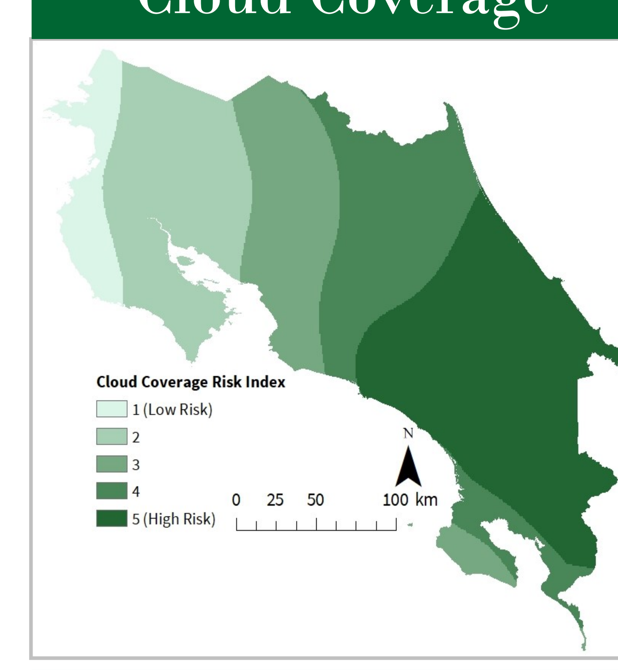
Altitude



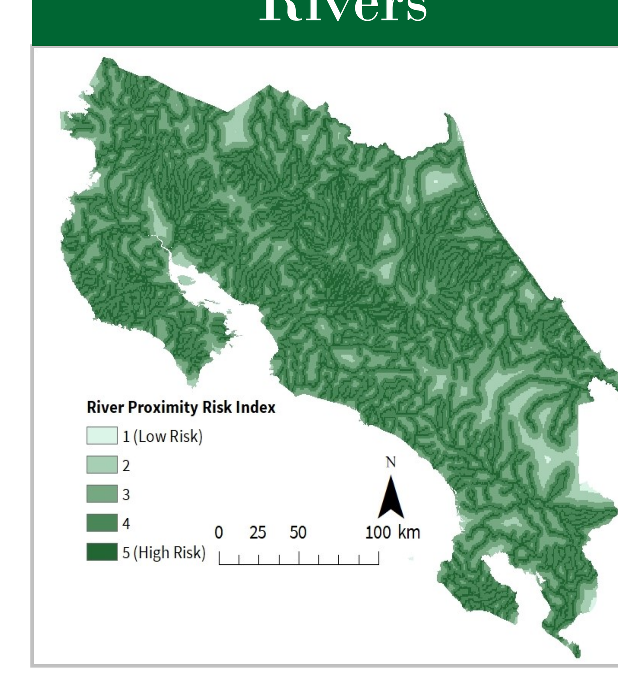
Evapotranspiration



Cloud Coverage



Rivers



Precipitation