Analysis of Amerindian Tribe Locations in Guyana

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Abstract

This paper examines the factors influencing the location choices of Amerindian tribes in Guyana. The Amerindian populations, which have lived in isolation for thousands of years, continue to practice some traditional methods of survival, including hunting with bows and arrows and agriculture. However, their ancient cultural practices are increasingly threatened by external factors such as climate change and the erosion of their traditional way of life. Using open-source spatial data, this study aims to analyze key geospatial factors, including vegetation, elevation, and access to water, that influence where these tribes establish their settlements. The findings seek to enhance understanding of the Amerindian culture and tribal locations compared to Guyana's total landscape.

Introduction

Guyana is a country located on the northern coast of South America. It was colonized by the British, making it the only English-speaking country in South America, and gained independence in 1970.[4] Since much of Guyana consists of rainforest, settlements have primarily remained near the coast. This has worked in favor of the first inhabitants of Guyana, the Amerindians.

The Amerindians live throughout Guyana, mostly in isolation. There are nine main Amerindian tribes, some of which still use traditional thatched roofs, hunt with bows and arrows, and farm cassava, a local plant. Over time, however, they are slowly becoming a lost culture, as their 11,000-year-old traditions erode. They are also increasingly affected by current crises, including climate change, which significantly impacts their agriculture.[2]

The Amerindian people can still use primitive techniques for survival, including hunting with bows and practicing agriculture. This results in a large reliance on natural resources, with a greater emphasis on tribal location compared to modern population centers, based on how they use these resources.

The aim of this paper is to utilize open-source spatial data to analyze the factors that contribute to the location choices of current Amerindian tribes in Guyana. Possible geospatial factors of interest include vegetation, elevation, and access to water. These insights could provide more information on

the isolated society.

Methodology

Data

Data was gathered from multiple different data sources and aggregated together across the whole country. To make use of all of the data and normalize it better from a combination different formats such as shapes, points or terra information, the country was subdivided into small squares. Every square has information about each variable with variables using either the centroid or the average across the shape for calculation.

Civilizations

The main objective of the paper is to identify compare Amerindian Tribal land compared to the rest of Guyana. The Amerindian tribal locations were gathered from a United Nations Development Programme for geographic use [1]. This shapefile contained estimates of current locations for Amerindian infrastructure including less populated agricultural areas and major tribal towns.

Current modern civilizations was aslo used to compare in analysis to the Guyanese landscape. The shapefiles used were from the ten census districts across Guyana including the originial location of settlements along the coast which have become major cities and also newer cities further inland [1].

Water Sources

Water is an important feature needed for survival and a basic human need. Water is used for drinking and agricultural. A dataset of all of the water lines, rivers, flowing through Guyana was used for proximity to natural surface water [1]. A distance metric was then computed across all of Guyana to get the distance to the closest natural surface water source.

Guyana is also a costal country with the northern border bordering the Atlantic Ocean. Utilizing the shape file of Guyana and a vector line of the coastal area, this distance to coastline was calculated across all of the country [1].

Vegetation

Vegetation is an important aspect for survival as it can provide natural plants, animals and also represent good areas for agriculture. The National Oceanic and Atmospheric Administration (NOAA) has a global dataset for global vegetation health products [3]. This dataset encodes information about the smoothed Normalized Difference Vegetation Index (NDVI) for a 4 km resolution. The data was limited to the cordinates and shape of Guyana with NDVI limited to [-1, 1] as there were outliers.

Terrain

The natural terrain of the landscape is also an important feature for where civilizations are settled, especially for societies with less ability to terraform the natural landscape. An elevation map was created by aggregating elevation over the ten main regions of Guyana [1]. The average elevation and slope across each grid square was calculated.

Methods

K-Function

The k-function is a global cluster indicator allowing for spatial point pattern analysis to access if how points are clustered if they are compared to a random distribution. The equation for k-function is:

$$\hat{K}(r) = \frac{a}{n(n-1)} \sum_i \sum_j I(d_{ij} \leq r) e_{ij}$$

The objective is to see how the distribution for the Amerindian tribe locations may be clustered. The Monte Carlo Method was utilized for significance testing which steps include:

1. Create a large number of random point pattens for H_0
2. For each patten, calculate k-function test statistical
3. Generate a histogram graph as reference distribution
4. Identify the 5^{th} and 95^{th} percentiles
5. Test Amerindian pattern against percentiles to reject or accept H_0

A comparative analysis of Amerindian Tribal locations versus random points will allow For assessment of spatial clustering patterns. This approach facilitates the identification of clustering tendencies at different distances, providing insights into the intensity or scale of such clustering.

Distribution Comparison

For each of the main variables of interest, a t-test was performed between Amerindians, Settlements, and the rest of the country. Variables:

- Minimum Distance to River Water
- Distance to Coastline
- NDVI
- Elevation

A t-test is a statitical test used to compare if there is a statistically significant difference between two populations or if their differences are due to random chance.

Logistic Regression

In the dataset, Amerindian land is marked as boolean and the geographic features are marked as numeric values. With the given geospatial dataset created, a logisitc model can be fitted to the data. Logistic regrssion is a statistical model which utilizes independent variables to predict a binary output.

To create a wholistic view of the area for the model, a geospatially lagged variable for each of the attributes is created. A lagged variable averages the 10 surrounding locations based on distance allows the model to account for geographically features of the surrounding areas. A fitted model will allow for analysis of which variables effect Amerindian tribal location and be able to project the probability of locations across the whole country leading places Amerindians could possibly be in the past or in the future.

Category	Distance to Coastline	NDVI	Distance to River	Elevation
Mean				
Amerindian	313010.24	0.37	6932.22	311.08
Cities	197990.39	0.38	2652.08	153.78
Uninhabited	231863	0.41	7163.31	200.77
Standard Deviation				
Amerindian	163378.62	0.08	5511.32	286.76
Cities	98818.56	0.09	2699.86	120.46
Uninhabited	144881.01	0.08	6132.42	206.26
t Statistic				
Amerindian vs Uninhabited	9.026	-7.832	-0.733	7.161
City vs Uninhabited	1.754	1.533	8.378	1.986
Amerindian vs City	5.538	-0.442	7.242	5.735
p-Value				
Amerindian vs Uninhabited	**<0.001**	**<0.001**	0.464	**<0.001**
City vs Uninhabited	0.09	0.137	**<0.001**	0.057
Amerindian vs City	**<0.001**	0.662	**<0.001**	**<0.001**

Table 1: Geographic Variables by Habitents

Results

Data

Figure 1 shows the Amerindian Tribal locations throughout Guyana. There location seems to be more to the east of the inland and near the coast with the larger tribal areas being inland and smaller areas near the coast. Roughly twenty percent of the land is Amerindian inhabited.

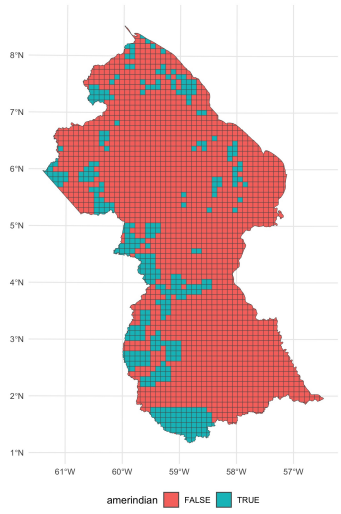

Figure 1: Amerindian Tribe Location

Figures 2-5 show the different main variables across the whole country. Figure 3 shows the rivers and the distance to the closet river, the figure shows that rivers span

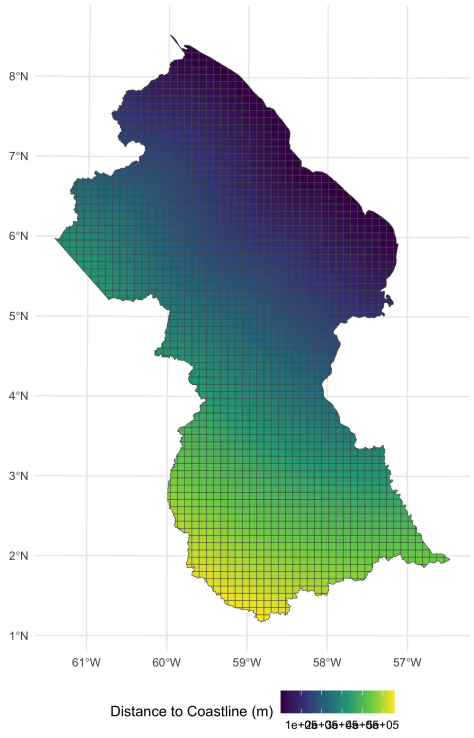

Figure 2: Coastline Distance

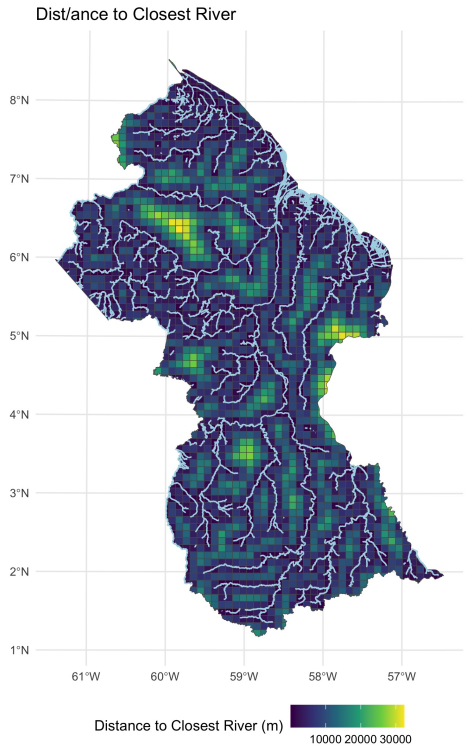

Figure 3: Distance to River

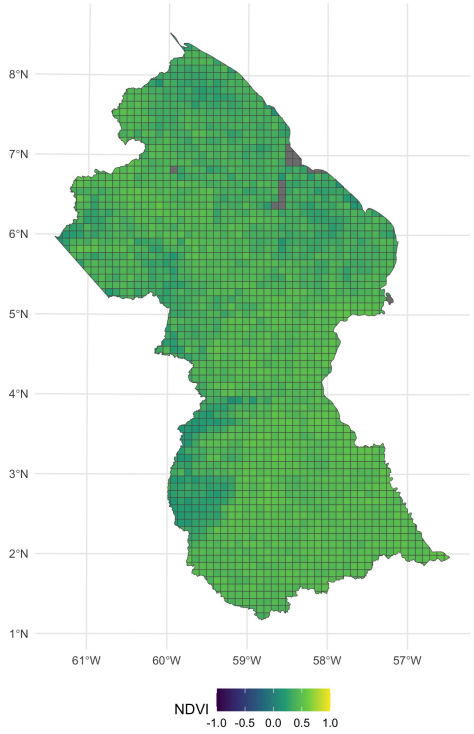

Figure 4: Vegetation (NDVI)

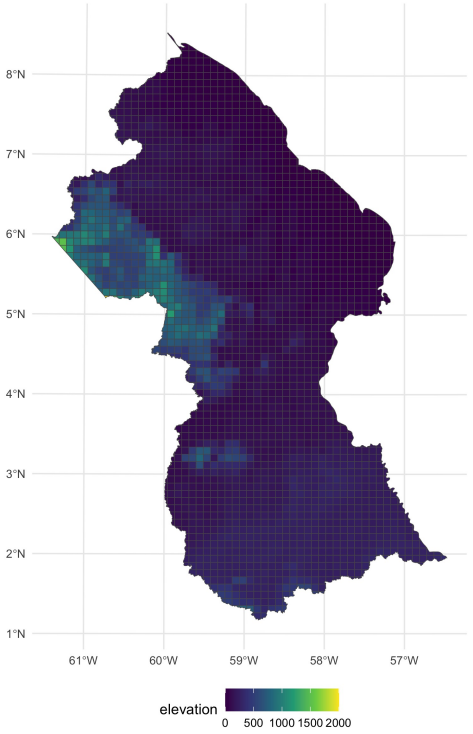

Figure 5: Elevation

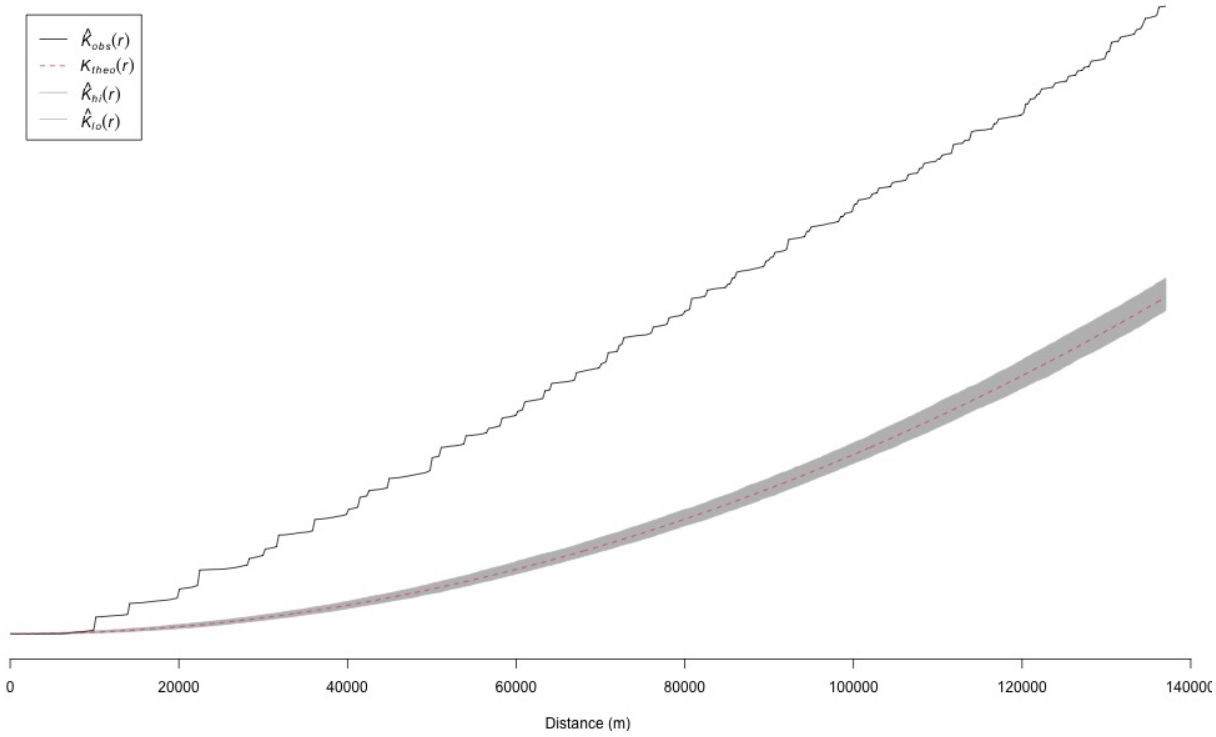

Figure 6: K Function Graph

throughout most of Guyana. Only two main regions in the map seem to be further from rivers compared to average. Figure 4 shows the vegetation through NDVI over the whole country. It shows that most of the country has high vegatation which makes sens as Guyana is mainly composed of foreset from the Amazon Rainforest. Figure 5 shows elevation across the country, the major noticable features is that Guyana is mostly flat throughout the whole country except for some mountainous area near the western border in the Essequibo region.

Comparing Distributions

For each of the vairables of interest, a statistical test was performend comparing their distributions between Amerindian Tribal locations, modern societies, and uninhabited land. Table 1 shows mean and standard deviation of each variable broken down based on who uses the land and the statistical test for significant differences between groups.

There are a few significant differneces between groups shown in Table 1. Amerindians tend to be significantly further from the coastline and rivers while at a higher elevation and lower NDVI compared to the rest of the country. Comparing Amerindians to modern civilizations shows their tribes tend to further from the coast, river and be at higher elevation.

Amerindian Tribal Clustering

There are many different major Amerindian tribe locations throughout the country. Looking at a grid breakdown of the country with a boolean of if the land in each

Variable	Estimate	Std. Error	z value	p-value
Intercept	0.7195	0.3518	2.045	0.0408*
NDVI	-0.2965	1.353	-0.219	0.8265
Minimum Distance to Water	-2.603e-05	1.814e-05	-1.435	0.1513
Minimum Distance to Coastline	2.308e-05	2.698e-05	0.855	0.3925
Elevation	-1.075e-03	8.097e-04	-1.328	0.1843
NDVI Lagged	-10.35	1.637	-6.323	**2.56e-10**
Minimum Distance to Water Lagged	9.213e-05	2.558e-05	3.601	**0.000317**
Minimum Distance to Coastline Lagged	-1.868e-05	2.702e-05	-0.691	0.4893
Elevation Lagged	0.002126	0.0008569	2.481	**0.0131**

Table 2: Logistic Regression Coeffients

grid contains Amerindian land, an analysis of clustering can be applied.

The k-function can be applied to these points which will allow multi-scale patterns of tribal points to be investigated. The k-function of tribal location was plotted with comparision to a random point significance envelope.

Figure 6 plots the k-function of both tribe location and and a random significance enevlope. Based on the figure, the k-function of tribal locations is always higher than a random distribution of the same number of points. This means that the Amerindian locations are statistically different compared to a random distribution. This statistical test shows that Amerindian tribes are clustered throuhgout the country and Amerindian land is not randomly distributed throughout the country even though their land is throughout the whole country as seen in Figure 1.

Logistic Regression

Fitting a geospatial geographic logisitc regression model with lagged variables results in a model with coeffients seen in Table 2. interestly, the most significance vairables based on pvalues include the lagged variables NDVI, distance to river, and elevation.

Predict	Actual	
	Uninhabited	**Amerindian**
Uninhabited	1487	120
Amerindian	425	263

Table 3: Confusion Matrix

Creating lagged geographic variables for the attributes of the average neighboring locations improved the AIC of the model, resulting in a better fitting model. Table 3 shows the confusion matrix from the model with the predited values. The model performs relatively well with 76% accuracy, 78% sensitivity, and 68% specificity.

The dataset is imbalanced where there is a significantly larger amount of data that is not tribal land compared to tribal land. This results in a shifted cuttoff of the percentage of the Amerindian over the whole country, 0.16, for the logistic probability outputs. While having a large imbalanced dataset, both predicted classes are relatively accurate without under or over sampling.

Figure 7 shows the projected expected lo-

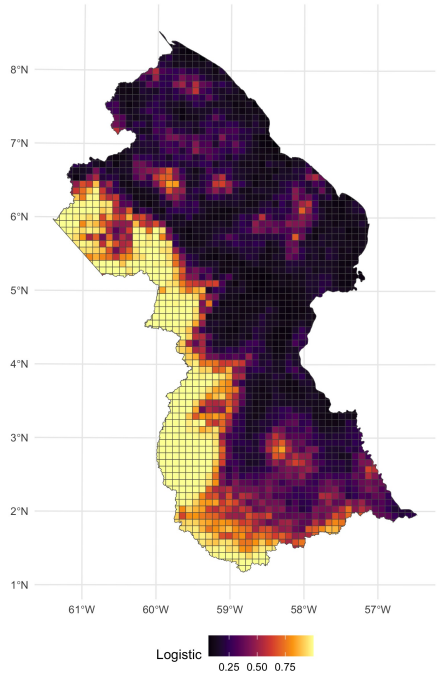

Figure 7: Amerindian Tribe Location

cations of Amerindian Tribes. Comparing predicted locations to actual locations in Figure 1, we can see the maps looks relatively similar. The predicted ares are similar on the west edge of the country where there is a large amount of tribal land and in the northern area where tribal land is sparsely distributed. Locations in the predicted map where there are no current tribal locations can be utilized for possible past or future tribal locations.

Conclusion

Thoughout this paper, an analysis of Amerindian Tribal locations was evaluated. Methods were utilized to dive into clustering of Tribe land, which natural features impact their locations, and a predicitve model on their location.

Tribe locations are both densely and sparsely distributed throuhgout the country depending on region. Utilizing the k-function, a statistical test found that their land is more clustered compared to if it were a random distribution of points. This makes sense as tribes may want to interact with each other and also be attracted to the similar locations which will increase their survival.

Comparing Amerindians locations to the rest of the country, we can see that they tend to be further from the coastline, live in slightly higher elevations and lower NDVI. While Amerindians farm, these farms probably have lower NDVI than the Amazon rainforest which may also have predators and more treacherous terrain which leads to areas with lower NDVI. Moving in-land is probably related to the higher eleavtion as Guyana's mountainous area is further from the coast on the western border with Venezuela.

The final part of the paper created a predicitve model of Tribe location. The input for the model uses geographic terrain of the specified spot and its surrounding area through a lagging variable. Using this model can help researchers understand where Amerindians may be and which locations could be appealing for them.

This paper hopes to bring insight in which factors can affect Amerindian tribe location. Through a better understanding of their society, more appreciation of how climate change and other global shifts are effecting them. Trying to preserve their society will help a civilization which has stood for over ten thousand years.

References

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