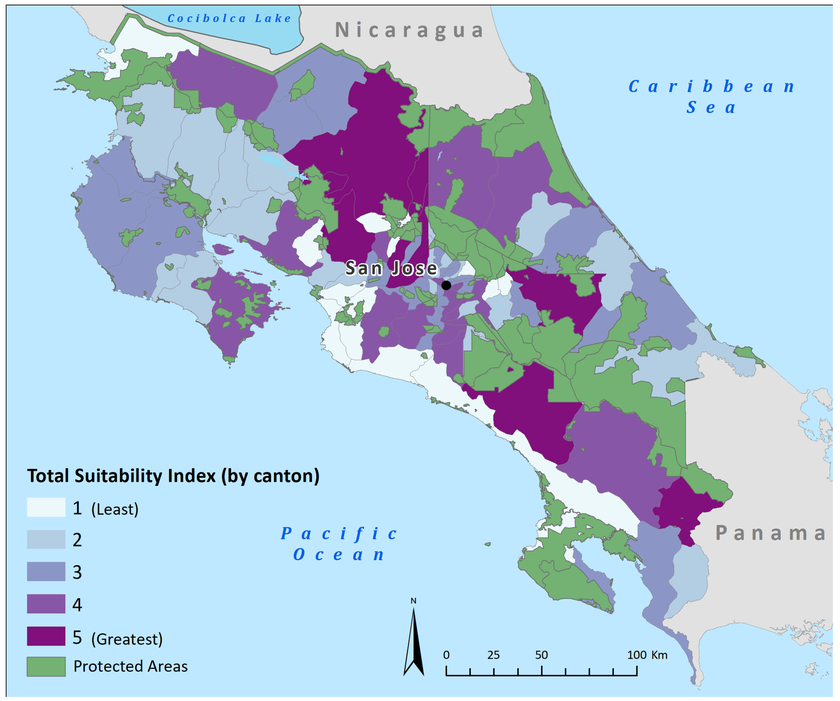
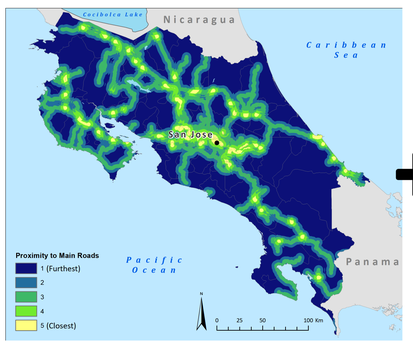
(BIO)FUEL UP — *A Biofuel Suitability Analysis for Costa Rica*

Background

Costa Rica has a rich history of environmental stewardship that springs from a robust democratic tradition and an unwavering commitment to protect its natural endowments. This tradition is strongly reflected in the government's energy policy. Renewable energy, for instance, is responsible for generating close to all of the country's electricity. In recent years, Costa Rica has experienced significant economic growth, out of which a large middle class has emerged. As a result, consumption has steadily risen, especially in the transportation sector. According to a study conducted by the United Nations, GHG (greenhouse gas) emissions in Costa Rica's transportation sector increased by an astounding rate of 9,012% between the years 1990 and 2005, reflecting this trend of increasing vehicle ownership. The government is conscious of this and has taken a number of steps to address this but much work remains to be done to curb GHG emissions. Biofuels — fuels derived from biomass — represent a promising means of transitioning away from gasoline given Costa Rica's high biomass potential. This study is two-pronged. First, it aims to assess overall biofuel suitability based on a range of agricultural and topographic indicators. Second, an economic analysis will be conducted to understand the extent to which the emergence of a biofuel industry would impact Costa Rica's working-age population.

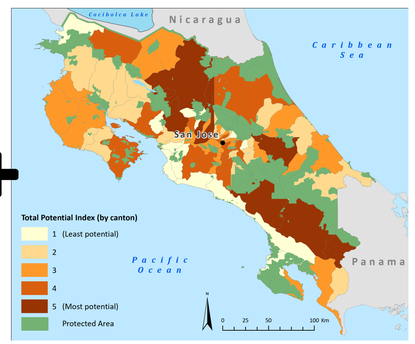


Transportation Network Analysis

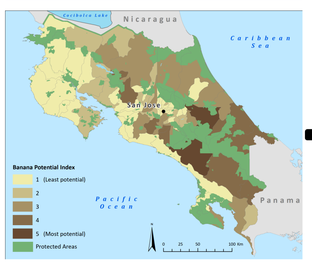


Slope Analysis

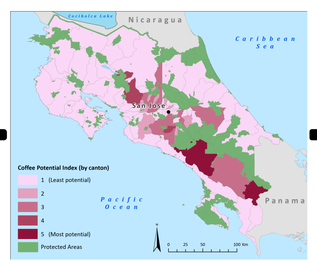
Agricultural & Economic Analysis



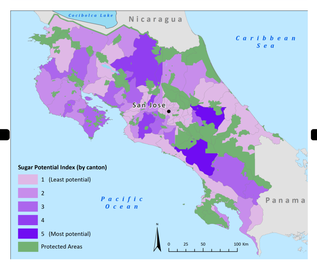
Banana Potential



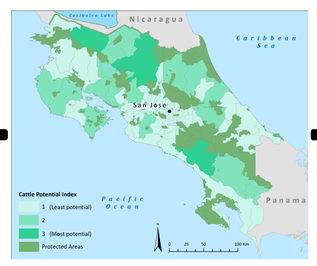
Coffee Potential



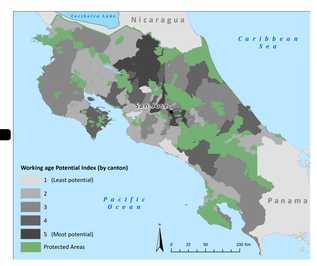
Sugarcane Potential



Cattle Potential



Employment Potential



Methods

Beginning with the agricultural potential evaluation, census data of banana, coffee, sugarcane, and cattle farms throughout the country were aggregated on a canton basis. Each canton first received a score from one to five (except cattle farms, which were scored from one to three) of each agricultural input based on the total amount of farms present in that canton. In addition, census data of the total working population in each canton was similarly scored to ascertain where the greatest employment potential exists. These indices were then combined to form a total agricultural and economic index.

For the topographical analysis, slope was calculated using a raster elevation data set and reclassified from one to five, five being the least steep and therefore, the most suitable for biofuel production. With respect to roads, vector data on both primary and secondary roads were combined to depict a transportation network suitable for a potential biofuel value chain. A Euclidian distance operation was performed on this data using the following distances from the roads as criteria: 2,000, 3,000, 5,000, 7,000, and 9,000 meters. These categories were assigned a score from one to five, the highest going to the smallest distance from the roads. The "zonal statistics as table" feature was then used to combine the raster data with the agricultural and economic vector data to facilitate an analysis on the canton level. Slope and proximity to road indicators were assigned scores based on their mean. These scores were added to the total agricultural and economic index to create a final suitability index. Scores for the cantons ranged from 9.36 to 26.25. For standardization purposes, these scores were reclassified into a scoring system of one to five, five representing the highest suitability.

Results

For this study, strong suitability refers to a score of 4 or 5 on the Total Suitability Index. Cantons receiving a suitability score of 4 include Acosta, Cartago, Curridabat, Desamparados, León Cortés Castro, Naranjo, Pococí, Puntarenas, Puriscal, San José, Santo Domingo, Sarapiquí, Tarrazú and Upala. Cantons receiving a suitability score of 5 include Alajuela, Buenos Aires, Coto Brus, Grecia, Pérez Zeledón, San Carlos, San Ramón and Turrialba. As indicated in the table, cantons receiving a score of 4 contain the largest share of the working-age population, thus showing the strongest employment and economic potential.

Total Suitability Index	Impacted Working Population	% of Total Working Population
1	131,397	4.2
2	427,622	13.7
3	675,196	21.7
4	1,385,972	44.5
5	494,794	15.9

Ben Levy | December 17, 2019 | DHP-P207 — GIS for International Applications (Fall 2019) | Projection: WGS_1984_UTM_Zone_16N (Transverse Mercator) | Sources: Instituto Nacional de Estadistica y Censos (INEC), Database of Global Administrative Areas (GADM), ESRI, CGIAR-CSI, OpentSreetMap, World Database on Protected Areas | Photo credit: Rainforest Alliance | Other sources: United Nations Climate Change Secretariat