THE ECOSYSTEM SERVICES OF GREENSPACES: LOCATING HIGHLY SUITABLE COMMUNITIES IN ALABAMA, UNITED STATES

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CONTEXT

Ecosystem services are all the goods and services that natural systems provide to humans, and they include land, water, soil, and air (Environmental Protection Agency 2020a). When these resources are well managed, the benefits can be mutually beneficial for humans and the environment, including unpolluted water, climate stabilization, species biodiversity, and natural hazard mitigation (Environmental Protection Agency 2020b). For example, healthy mangrove forests along the Florida coastline protect the coastline from wave and storm erosion that can be brought about by tropical storms and hurricanes. Both life and property, as well as coastal ecosystems are protected by this service that mangroves provide. However, disaster arises, and vulnerability increases when these ecosystems are poorly managed. The effects of social and political processes can cause destabilization from local to global scales. Land use change, pollution, and greenhouse gas emissions fundamentally change the ecosystems that provide these necessary services and lead to these grand challenges, like climate change.

Climate change, as we know it today, is driven by anthropogenic forces on environmental systems. One of the prominent alterations to the climate system that humans have caused is changing the landscape for various purposes. An example of the impact of land use change on the climate in the Southeast US is the average temperature decline in the last approximately 100 years due to the transition from row cropping to a more forestry-dominated industry (Costanza et al. 2016). However, in the last approximately 40 years, there has been a positive trend in average temperature likely due to rapid urbanization in the region (Lloyd 2012). This is exemplified in the urbanization seen in Alabama counties, specifically. Montgomery, Jefferson, and Lee are among the many counties seeing rapid expansion. This is particularly worrisome because warming climate coupled with rapid urbanization have the potential to cause enhanced warming effects.

One of the most well-studied impacts of urbanization on climate is the phenomenon of the urban heat island (UHI) effect where urban centers are hotter than surrounding rural areas (Royal Meteorological Society 2021). Generally, the building materials in urban settings have much lower albedo leading to higher solar energy absorption (Institution of Civil Engineers 2021). Some of the factors that affect the intensity of the UHI effect include population or building density, land cover type, and income. Population and building density have a positive relationship with UHI meaning the denser the area is the more likely a person in the area is to experience a greater UHI effect than someone living in a less dense urban area (Ramírez-Aguilar and Souza 2019). Land cover that is more urban results in more intense UHI (Chen et al. 2006). Lastly, income is negatively related to UHI in that if a person has a lower income, they are more likely to be subjected to more intense UHI effect (Vargo 2016). These factors are expounded upon in this study.

Extreme and enhanced heat like those seen in urban settings have direct impacts on human health. These morbidities include diseases that are both caused and exacerbated by extreme heat. Dehydration, hypothermia, and heat stroke, for example, can be caused by extreme heat whereas respiratory, cardiovascular, and renal disease can be exacerbated by it. However, the installation of greenspaces has positive benefits for environmental, economic, and health in a society. Environmentally, greenspaces can increase carbon dioxide drawdown and dispel heat through plant evapotranspiration (Zhang, Gao, and Yang 2014). Economically, greenspaces can lower the energy demand from cooling buildings (Zhang, Gao, and Yang 2014). The health benefits of greenspaces have been unclear regarding the direct benefits of greenspaces. However, indirectly, increased likelihood of physical activity by being in proximity to a greenspace can lower the risk of certain morbidities that are worsened by extreme heat and can improve mental health and quality of life (Dadvand 2016).

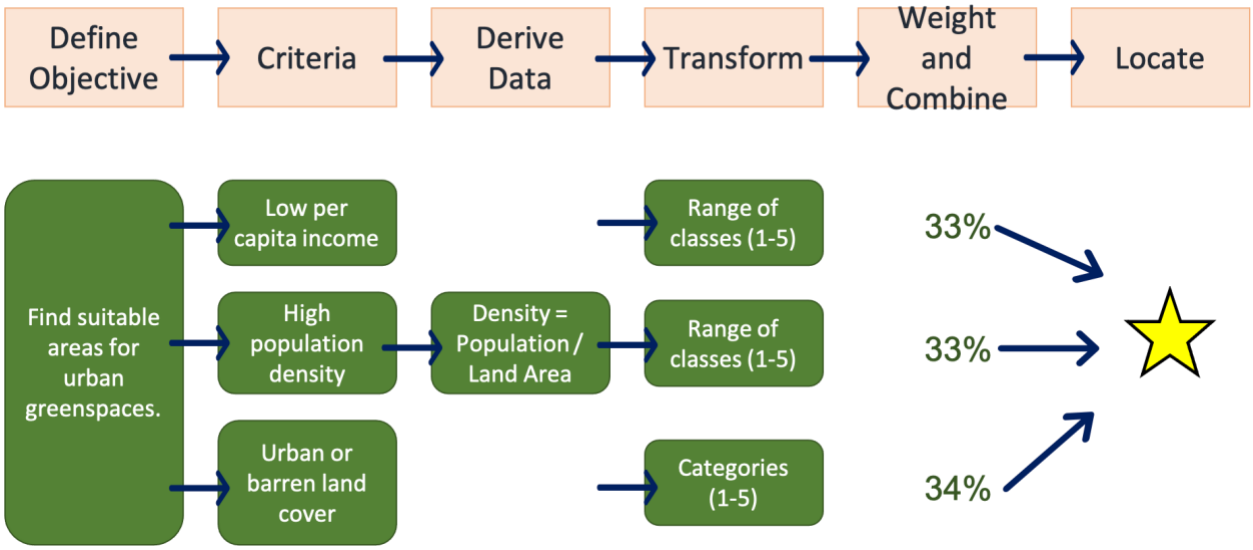
Since the climate of the Southeast US is expected to continue to rise with increased urbanization and greenhouse gases in the atmosphere, it is important for urban centers to address this impending public health challenge. The aim of this project

was to identify prospective areas with high suitability rankings for installing urban greenspaces in Jefferson, Montgomery, and Lee counties in the Southeast US.

DATA AND METHODS

Per capita income, population density, and land cover data in were used as the criteria for urban greenspace suitability in Alabama cities. Per capita income per census tract data was transferred from the 2010 American Community Survey via Integrated Public Use Microdata Series (IPUMS) National Historic Geographic Information System (NHGIS). Population density was calculated by dividing population by the land area of the census tract. Population density for each census tract was transferred from the 2010 Census via IPUMS NHGIS. Land area was provided in the U.S. Census Bureau TIGER/Line census tract shapefile. Land cover data was downloaded from the 2011 National Land Cover Dataset (NLCD) via the United States Geological Survey (USGS).

Finding suitable regions for greenspaces in Alabama cities was completed using the suitability modeler in ArcGIS PRO 2.7. A suitability model is used to identify ideal locations for a specific purpose based on certain criteria (ESRI 2021). Figure 1 illustrates the workflow for this study. The criteria used as inputs for the suitability model were low per capita income, high population density, and urban or barren land cover. The inputs were transformed into 5 classes: per capita income and population density ranges were grouped into five classes. Lower per capita income was given a higher ranking, and higher population density was given a higher ranking. Urban or barren land cover was given a higher ranking while water bodies and forested regions were given a lower ranking. Since this was an exploratory study, the criteria were weighted about equally.

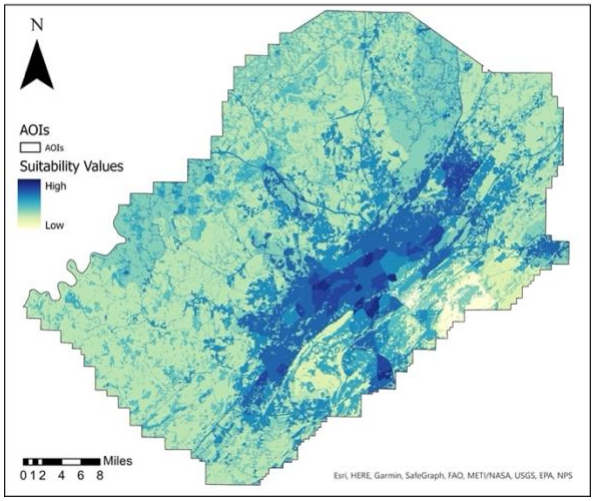


RESULTS

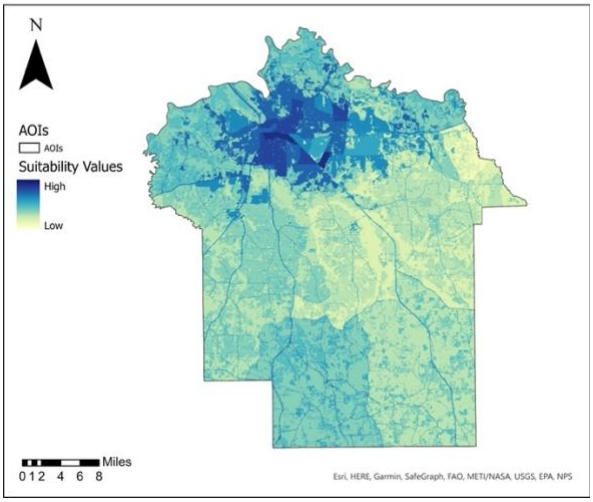
A suitability analysis was performed on Jefferson, Montgomery, and Lee counties in Alabama to determine the most ideal location for urban greenspaces based on population density, per capita income and land cover type. The areas in Jefferson County that were most ideal for greenspaces were Central Park, Bush Hills, Inglenook, Forest Park, and Woodmeadows areas (Figure 2). In Montgomery County, the Old Cloverdale and Woodland Hills areas were most suitable for greenspaces

(Figure 3). In Lee County, areas just west of Auburn University's campus were the most suitable regions for greenspaces (Figure 4).

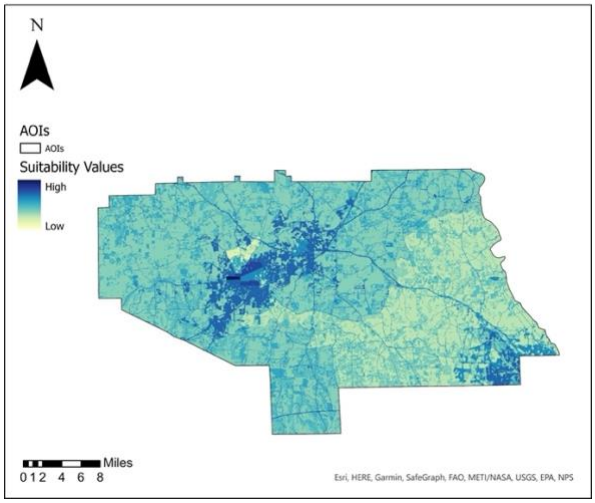
Suitability Model Output - Jefferson County, Alabama



Suitability Model Output - Montgomery County, Alabama



Suitability Model Output - Lee County, Alabama



CONCLUSION

Suitability modelling can help community members are social geographers identify ideal locations for greenspaces. Several areas in Jefferson, Montgomery, and Lee counties in Alabama make ideal starting locations for greenspaces. Evaluating suitable regions and including socioeconomic factors ensures that the people who need greenspaces most access them.

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