College of Environment + Design
UNIVERSITY OF GEORGIA

Measuring Landscape Connectivity in Northwest Chatham County, Georgia, USA

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1. Introduction

Landscape connectivity is a critical issue for ecosystem service and biodiversity conservation, as well as dealing with habitat fragmentation which is caused by urban sprawl. Green corridors that connect isolated remnant habitat patches can increase connectivity and provide ecosystem services in urban areas.

Circuitscape, Linkage Mapper, and GIC are all connectivity analysis tools designed to model species movement and to identify areas important for connectivity conservation. In this project, the core habitat areas and the ecological corridors will be identified by these tools, and the results will be compared together to testify the effectiveness of different approaches.

2. Study Area

In this project, the study area is on the northwest part of Savannah City (Fig.1), which is the Chatham county seat and one of the fast-growing cities in Georgia, USA. It is selected by the fragmentation degree and the zip code districts. The area is 130.8 mi^2. The west part of Chatham County is mainly agricultural and undeveloped land. This is a suitable area for calculating the corridors since the fragmentation degree is higher than the east part, where most of the lands are marsh area and open water.

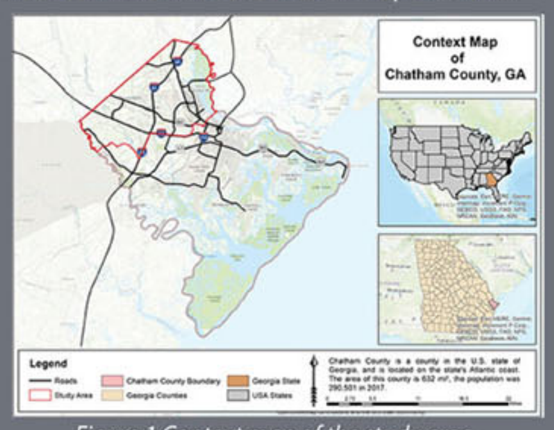


Figure 1 Context map of the study area

3. Methodology

3.1 Measure connectivity by the GIC tool

GIC tool developed based on the book Strategic Green Infrastructure Planning (Firehock, 2015). There are four functions. The "create cores" function will identify the core habitats from the local green infrastructure, which is a planned network of wilderness, parks, greenways, conservation easements, and working lands with conservation value that supports native species (Firehock, 2015). After identifying the core habitats, the other function "Corridor Analysis" will be used for identifying the least-cost corridors.

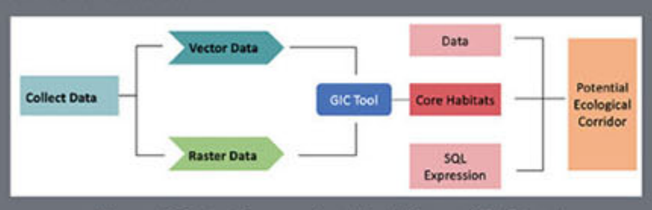


Figure 2 Data Processing Workflow of GIC tool

3.2 Measure connectivity by Circuitscape

The input datasets are a raster resistance map and a raster focal node map. The raster resistance specifies the resistance to movement at each cell in a landscape, while the focal node map specifies core habitat areas, which are the results gotten by the GIC tool, between which connectivity is to be modeled. In this case, resistance values are based on the land cover map of the National Land Cover Database, vary from 1 to 15 according to the land cover type. The forest area is assigned the value 1, and the areas where highly developed and hard to cross by animals are assigned to be 15. Circuitscape will create a graph by converting resistance cells to nodes and connecting them to their immediate neighbors. There will be a cumulative current map and several voltage maps, the quantity is based on the number of pairs.

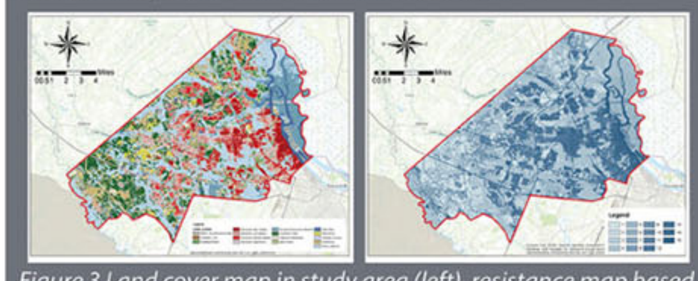


Figure 3 Land cover map in study area (left), resistance map based on the landcover (right).

3.3 Measure connectivity by Linkage Mapper

In this project, the Linkage Pathways tool will be used for calculating the least cost path. It uses maps of core habitat areas and resistances, which is the same as the data used in the Circuitscape, to identify and map linkages between core areas. Therefore, in this case, the resistance model will just include landcover data without species-specific landscape resistance models.

Core Habitats and Least Cost Corridors Identification by GIC

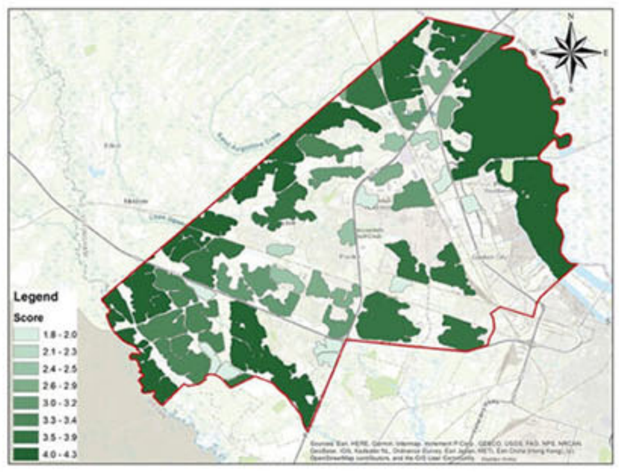


Figure 4 Core habitats calculated by GIC tool

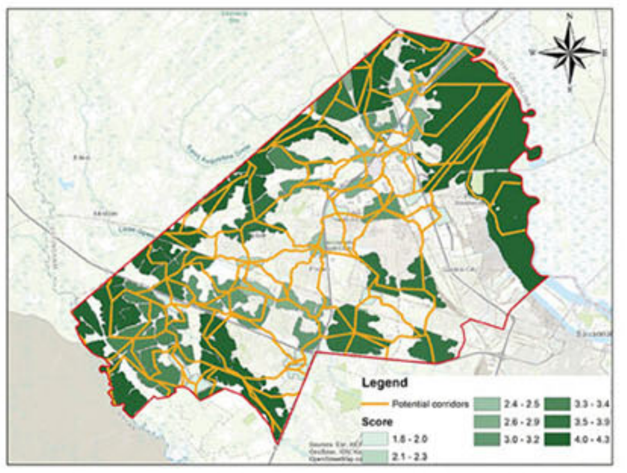
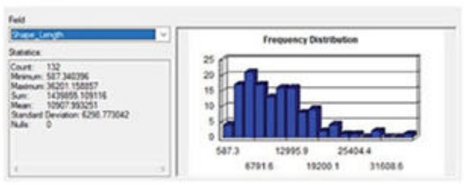


Figure 5 Potential wildlife corridors in Study Area

Core habitats are undisturbed land areas at least 100 acres in size and at least 200 meters wide (Esri). Meanwhile, other factors should be considered, such as soils, elevation, endemic species. The map (Fig. 5) indicates all the potential wildlife corridors in the study area. There are 132 corridors with 270 miles of length for connecting 55 habitats, and the mean value for the length is about 2 miles.



Current and Voltage Map Calculated by Circuitscape

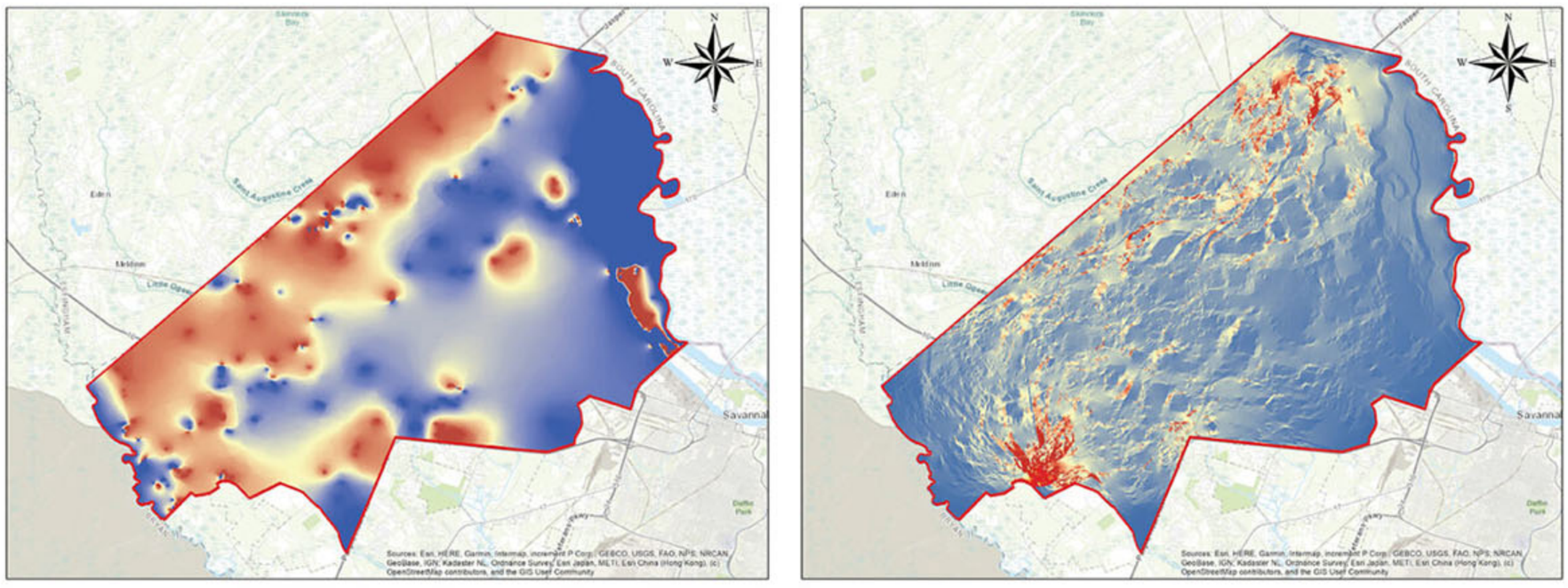


Figure 6 Voltage map (left) and the current map (right)

As shown in Fig. 6 (right), the current map with warmer shades showing higher current flow (red color is the highest while blue is the lowest). It reflects a clear current direction from north to south and is mainly concentrated in the west part of the study area, where the core habitat areas are denser. And for the voltage map (Fig. 6 left), it has a proportional relationship with current map. The districts with higher voltage have a higher current according to the map. The maps look like the water flowing from the north core areas to the south, current is the water's speed, and voltage is the water level. The road system acts like dams. The clear dividing line in the voltage map is where the I-95 goes across the county. The parts where are abrupt color transitions should breach a dam to increase the flow.

Corridor Map Calculated by Linkage Mapper

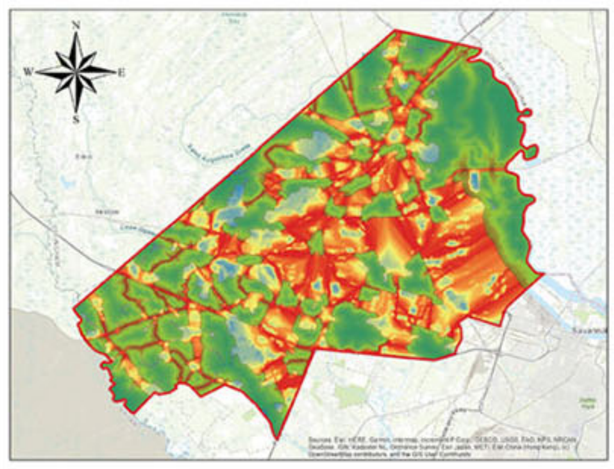


Figure 7 Linkage corridor map combined with core habitats

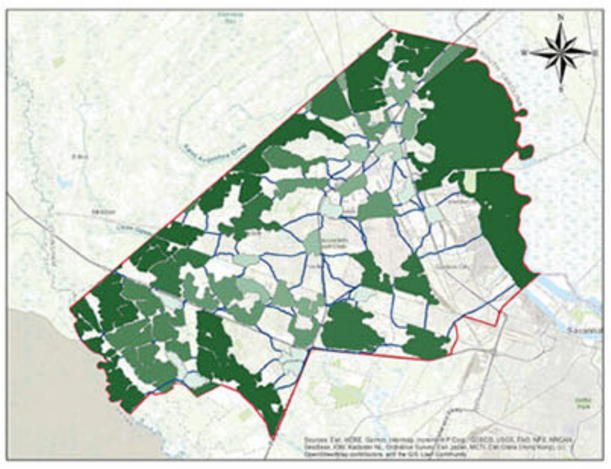
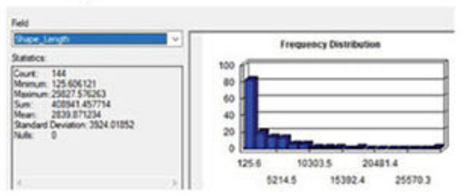


Figure 8 Linkage Mapper least cost pathways map

The calculating result (Fig. 7) shows the relative value of each grid cell in providing connectivity between core areas. The blue areas have higher resistance values, the corridors planning on the red color areas should be more available in this case. In Fig. 8, there are 144 corridors with a total distance of about 77 miles. The frequency of the shortest corridors is highest because of the high degree of landscape fragmentation in the study area.



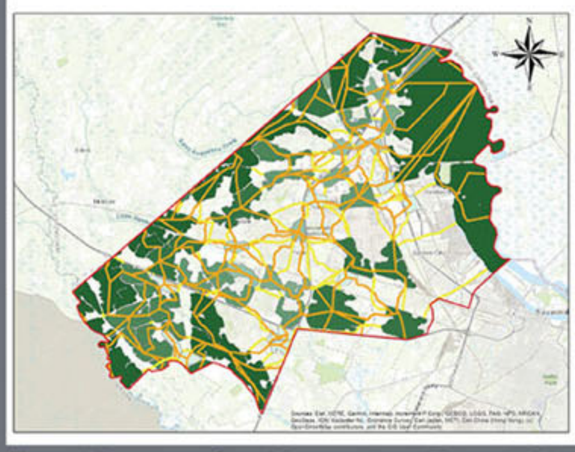


Figure 9 Two types of corridors overlap with core habitats

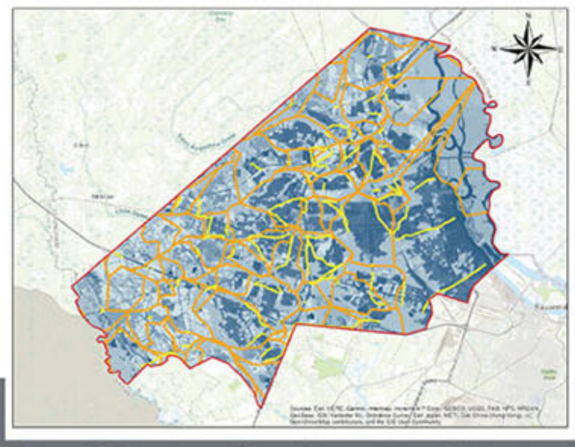


Figure 10 Two types of corridors overlap with landcover

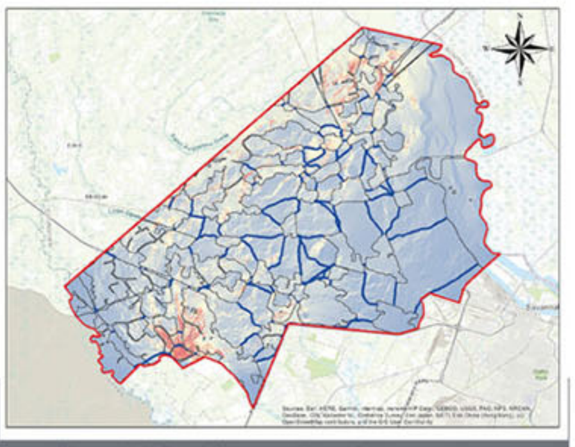


Figure 11 Corridors overlap with current map

4. Discussion and Conclusion

These corridors based on the Linkage mapper are the distance between the edges of core habitats while the GIC calculates the distance between the centroids. This is the reason why the length from GIC corridors is much longer than the corridors from Linkage Mapper. Even though they have a similar number of corridors, the total length differs by twice. On the other hand, most of the two types of corridors are not overlapped together. The corridors of GIC mainly go through areas with low resistance values, while some of the Linkage corridors go across the developed areas with higher resistance values.

The methods present in this project show great potential in effectively characterizing the core habitats and ecological corridors. According to the results of Circuitscape and Linkage Mapper, there is an obvious preference to show where are the important parts for corridor construction. While in the GIC tool, the calculating result with relatively even distribution of corridors.

Main References:

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Fahrig, Lenore. 2003. "Effects of habitat fragmentation on biodiversity." Annual review of ecology, evolution, and systematics 34 (1):487-515.

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McRae, B. H., and V. B. Shah. "Circuitscape User Guide. The University of California, Santa Barbara, California." (2011).