Using GIS and Fragstats to Predict the Biodiversity of Vegetation from the Landscape

A Review of "Relationships between landscape patterns and species richness of trees, shrubs and vines in a tropical forest"

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Introduction

The purpose of J. Luis Hernandez-Stefanoni's research aimed to distinguish how different metrics of landscape fragmentation relate to biodiversity by analyzing the predictive power of different groups of landscape metrics on plant diversity in the tropical forest region surrounding Quintana Roo, Mexico. The author asserted that two main determinants of biodiversity are "the degree of fragmentation" and "connectedness of ecosystem components," which are both influenced by natural disturbances and anthropogenic interventions (Hernandez-Stefanoni, 2005, p. 53). So, if a higher degree of landscape fragmentation were observed via metrics of area/edge, shape, isolation/proximity and contrast, then a lower degree of biodiversity would be expected in observed plant richness. This was the logical framework of the paper. More specifically, Hernandez-Stefanoni used GIS, FRAGSTATS, and the Akaike Information Criterion to determine the model that best predicts plant diversity in trees, shrub, and vine species from the different groupings of landscape metrics mentioned previously. The author also drew upon past research to justify the metrics he analyzed as predictors of biodiversity, which supports the concurrent validity of the study.

Methodology

The study incorporates indigineous terminology in the classification system of the landscape. See Table 1 provided below for further reference.

Inidigenous Classification Term	Age Range	Vegetation Description
Kanah kax	20 - 60 years	Forest
Kelenche	11 - 19 years	Variable Vegetation
Juche	4 - 10 years	Plants
Saakab	< 3 years	Plants

Akalche	Variable	Savanna

Table 1 (Information listed on p. 54)

However, the data was pooled and reclassified due to limitations in calculating the variograms for every vegetation type. See Table 2.

Classification for Kriging and Statistical Analysis	
Forest 1	Kanah kax and Kelenche
Forest 2	Juche and Saakab
Secondary Associations	Akalche or Savanna

Table 2 (information listed on p. 57)

The study area consisted of 64 km^2. In the field Hernandez-Stefanoni sampled 141 total sites, mixed between 10m by 10m quadrats for tree and vine species richness samples and 5m by 5m quadrats for sampling shrub species taller than 1m. Figure 1 is a landscape map of the study area obtained from Landsat 7 Thematic Mapper™. The image analysis software, 'Maximum Likelihood Algorithm,' from Earth Resources Mapper™ was used to classify the landscape accordingly with the indigenous classification scheme in Figure 1. Hernandez-Stefanoni also classified each of the 141 sites using the indigenous classification system and determined the Earth Resources Mapper software was roughly 80% accurate in classifying those sites (p. 55). This raster data was then exported to GIS IDRIS, which is now known as TerrSet. Hernandez-Stefanoni fails to clarify the resolution of raster cells, which undermines the ability to repeat this study. Nevertheless, the raster data was then exported to FRAGSTATS 3.0 to obtain landscape metrics. See Table 3 for landscape metrics and their associated 'Type of Metric.'

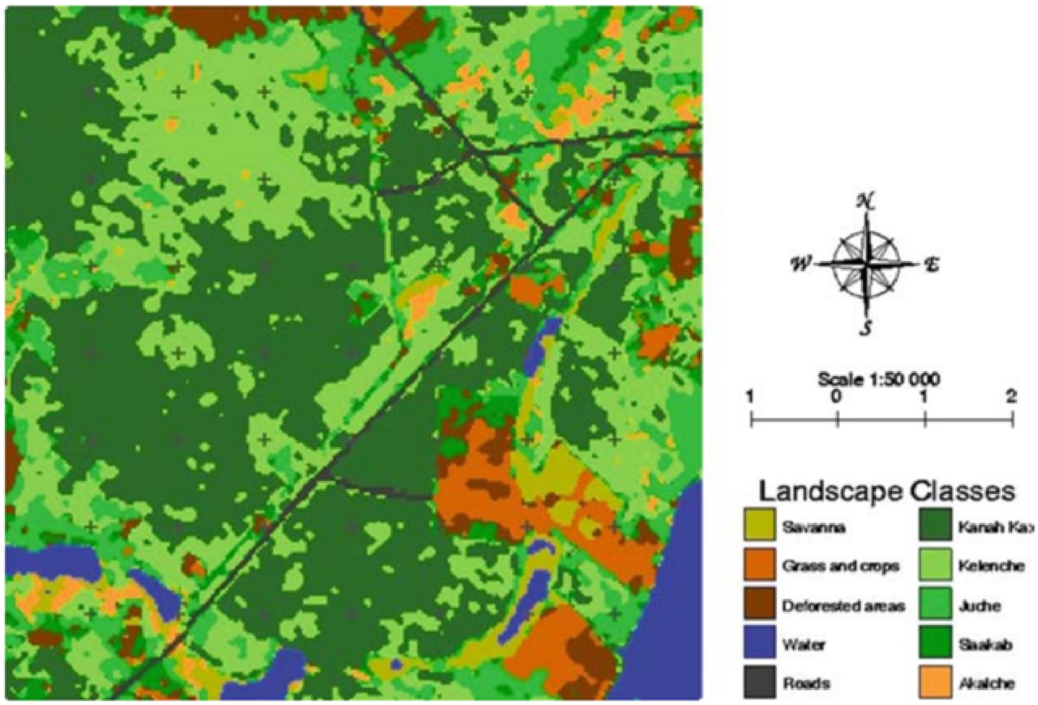

Figure 1 (Hernandez-Stefanoni, 2005, p. 55)

Type of Metric	Landscape Metrics Calculated
Area / Edge	Patch Area and *Patch Perimeter (later omitted in the Akaike Information Criterion)*
Shape	Perimeter-Area Ratio, Shape Index, and *Fractal dimension index (later omitted in the Akaike Information Criterion)*
Isolation / Proximity	Proximity Index, Similarity Index, and Euclidean Nearest Neighbor Distance
Contrast	Edge Contrast Index

Table 3 - Information extracted from Table 1 in Hernandex-Stefanoni, 2005, p. 56.

Hernandez-Stefanoni used stratified kriging between each class' data sampled from the 141 sites and produced contour maps of the number of species. Hernandez-Stefanoni fails to cite the software he uses to make these maps, which again undermines the ability to repeat the study. Kriging is a common tool used in GIS analyses to interpolate values and create a continuous surface, so one of the available GIS softwares at the time was used, likely ER Mapper because that is the only mapping software mentioned in the study. Figure 2 shows the species richness contour maps he produced.

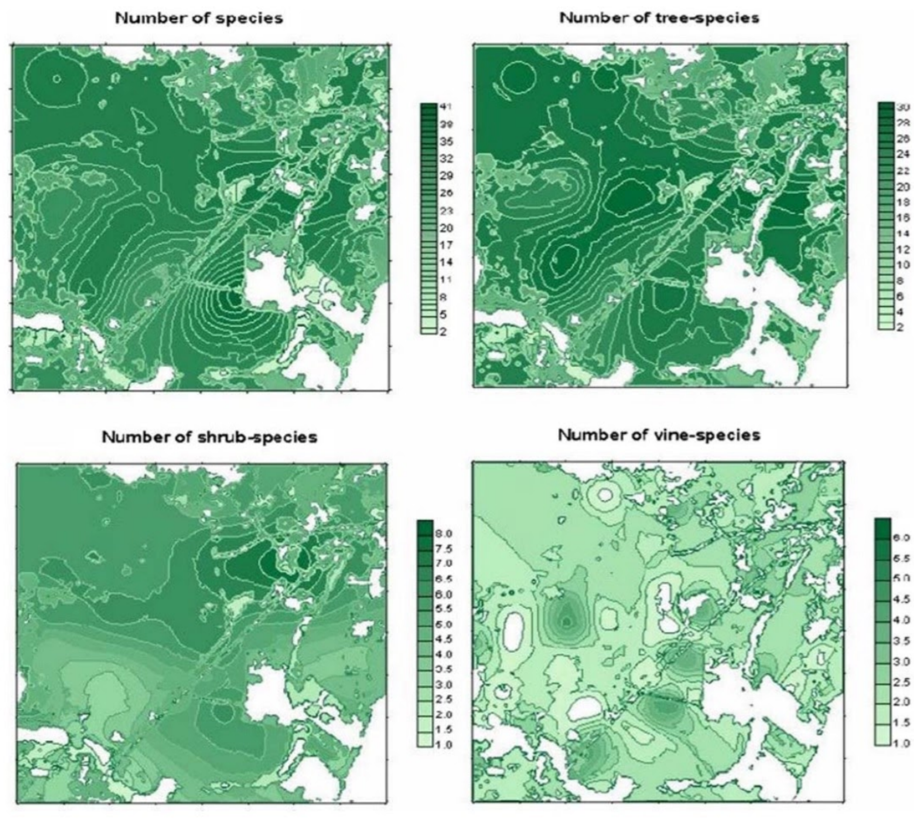

Figure 2 (Hernandez-Stefanoni, 2005, p. 60)

Conclusion & Critique

Hernandez-Stefanoni found that different combinations of landscape metrics have strong associations with the numbers of species found for particular patches. Hernandez-Stefanoni (2005) concluded that the degree of contrast, represented by the edge contrast index metric, best influenced the species richness measured in a patch (p. 61). Additionally, he claims the degree of isolation/proximity, measured by proximity index and similarity index, also heavily influenced the species richness of a patch (p. 62). All of these metrics were used in the model that rendered the highest weighted Akaike Information Criterion across tree, shrub, and vine species richness levels.

I would give this study an 8 out of 10. Hernandez-Stefanoni's research is exemplary of what a full spatial analysis process entails; field work, digitization of the data collected, critical statistical analysis of the data, and logical inferences drawn. He also referenced indigenous knowledge for his classification system, which speaks to the localized validity of the study. Although the research was focused on fragmentation, Hernandez-Stefanoni could have acknowledged other confounding variables such as elevation in his work. His failure to mention the software used in creating the species richness contour maps and the resolution of the raster data also takes away from the repeatability of the study. Nevertheless, Hernandez-Stefanoni mostly employed appropriate spatial analysis techniques to ensure validity and present potential areas of uncertainty. For example, he back checked the Earth Mapper image analysis software's predicted classifications with his own classifications from his field work, and determined there was no spatial autocorrelation in plant diversity within patches by analyzing Moran's I z-scores between each species. Furthermore, he gave clear justification for how the weighted Akaike Information Criterion scores pertain to the causal relationship between a particular model using a combination of landscape metrics and the corresponding species richness for trees, shrub, and vines. This research may help ecologists that are mathematically savvy to better understand how the degree of fragmentation and patch isolation/proximity in a landscape influence plant diversity similarly across different species.

Bibliographic Information

Hernandez-Stefanoni, J. L. (2005). Relationships between landscape patterns and species richness of trees, shrubs and vines in a tropical forest. *Plant Ecology, 179*(1), 53-65. doi:10.1007/s11258-004-5776-1