

Examining Spatial Heterogeneity and Tourism Potential of Water Resources in New Mexico

Jason Banegas

College of ACES

Water Science and Management



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Introduction

- Outdoor tourism in NM is growing
- Strategies necessary for water based tourism planning.
 - Market Forces vs. Focused Development
- Conservation/Preservation of resources
 - Tourism management
- Economic and Community Development



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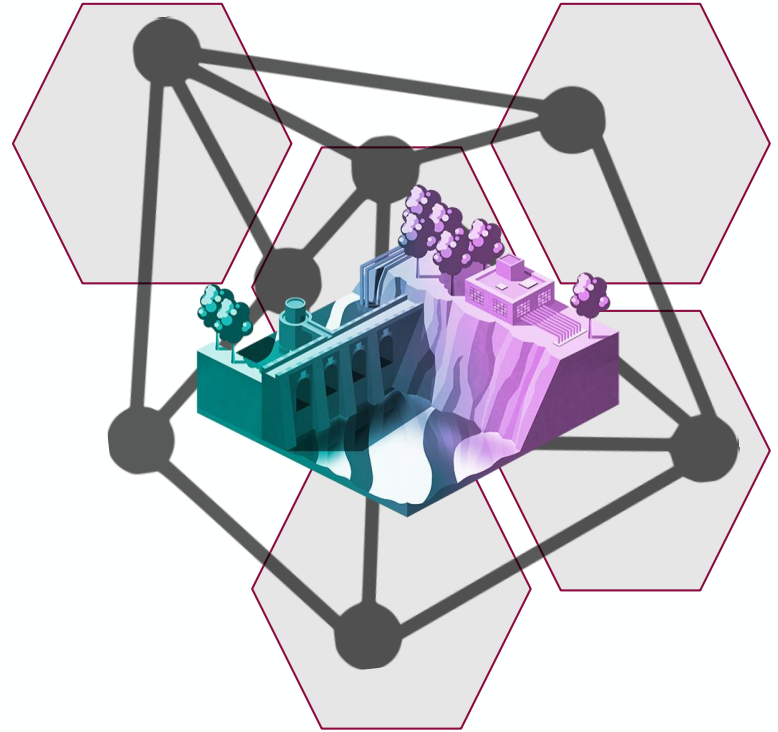
Introduction

- Tourism models almost always developed for urban/suburban locations.
- Contextual differences between water based tourism amenities in rural and urban areas.
- Need for research that investigates diverse spatial relationships.



Research Trends

- Tourism research methods: Surveys, Mathematical Models, Algorithmic Ranks, Geospatial, etc.
- Few GIS-based analyses of water tourism amenities.
- Fewer incorporate urban/rural distinctions.
- Spatially explicit models for real-world Urban/Rural water tourism planning needed.

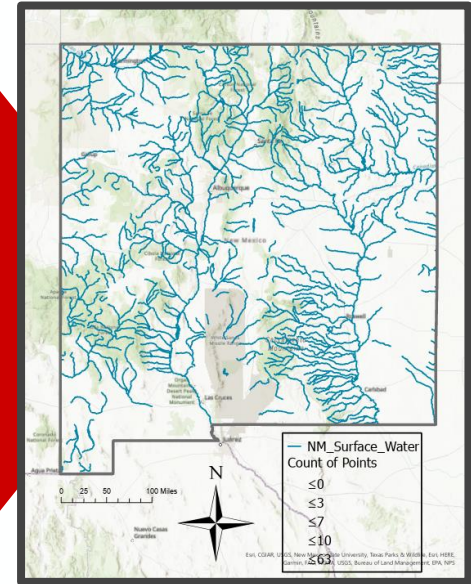


Objective

Address
deficiency in
research of
Urban/Rural
water
tourism
comparisons

Characterize
contextual
factors and
location
selection
characteristics

Explore the
regional
variation of
water
tourism
resources in
New Mexico
using GIS



Policy Relevance

Design
a method
that policy
makers can
utilize for
water tourism
planning

Identify
areas where
resources
and planning
should be
directed



Data and Methods of Analysis

- The GIS-based methodology and variables selected for this study come from factors presented in: Vukovic 2022, Narvaez et al. 2020, Magige et al. 2020, others.
- ESRI's ArcGIS Pro 2.6.1 software for data processing, spatial analysis, and creation of visualizations.

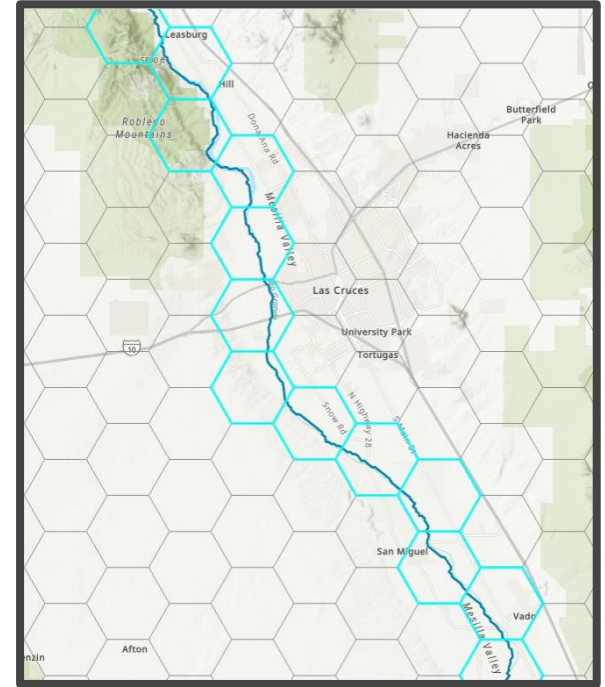


Study Area

- 18,234 10^2 Mile tessellated hexagons overlaying NM.
 - 121,590 square miles
 - 253 hexagons contain incorporated populations
 - 99 percent of land considered Rural
 - https://www.ers.usda.gov/webdocs/DataFiles/53180/25586_NM.pdf?v=0

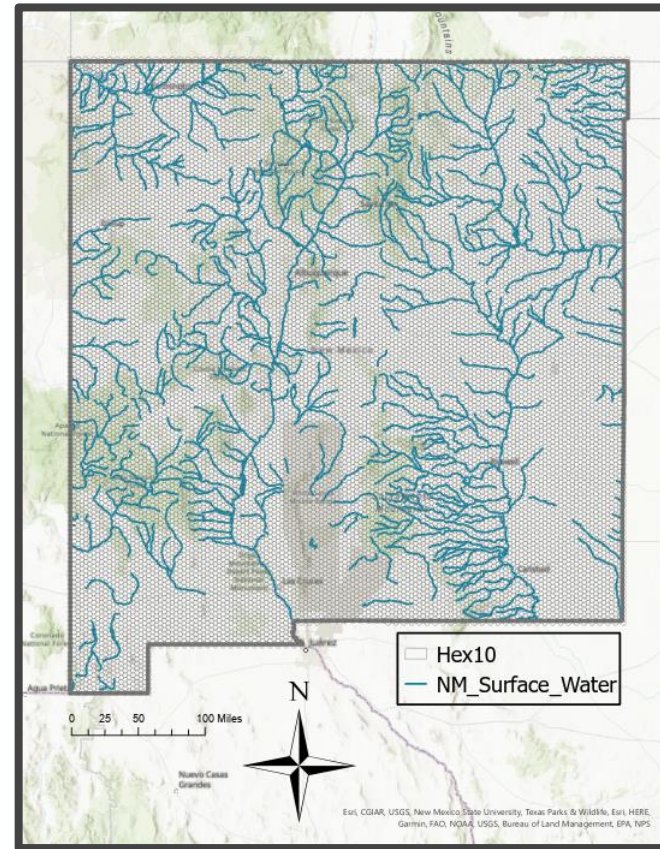
Population and Density of New Mexico's Urban and Rural Regions

	New Mexico	Urban	Rural
Population	2,092,434	1,012,581	1,079,853
Pop. Density	17.25 / sq. mile	1756.03 / sq mile	8.95 / sq mile



Dependent Variable: # EVCS

- 18,234 10^2 Mile tessellated hexagons overlaying NM.
 - 991 Geo-tagged River Photos
 - (379 Inc. Places)
 - 644 Geo-tagged Lake Photos
 - (37 Inc. Places)
 - 50 Geo-tagged Hot Springs Photos
 - (9 Inc. Places)
 - 1,685 data points used as proxy for tourism traffic
 - 75% are located in Unincorporated/Rural areas



Explanatory Variables

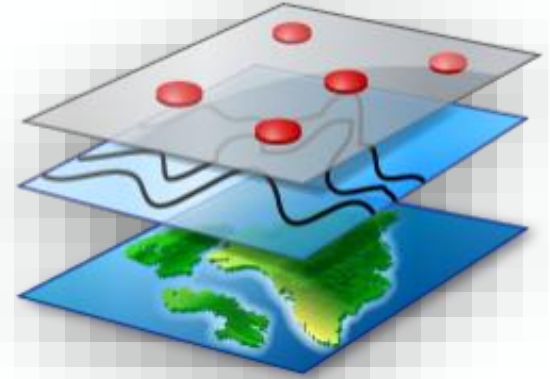
- 12 attributes based on inclusion in prior tourism site selection research.
- Restrictive or selective.
- Continuous, binary, and count data.
- Given equal weight regarding qualitative differences.

Variables Used and Expected Direction of Relationship

Variable	Expected Sign
Rental Housing Units per Capita	-
Museums and Cultural Centers	+
Recreation Sites	+
Gini Coefficient	-
Hospitals and Nursing Homes	+
(Log) Air Traffic	+
Highways Tract Area Ratio	+
Proximity to 4 yr Higher Ed	+
Education Percentage	+
Government and Community Resources	+
Population Density	-
Public Land Access	+

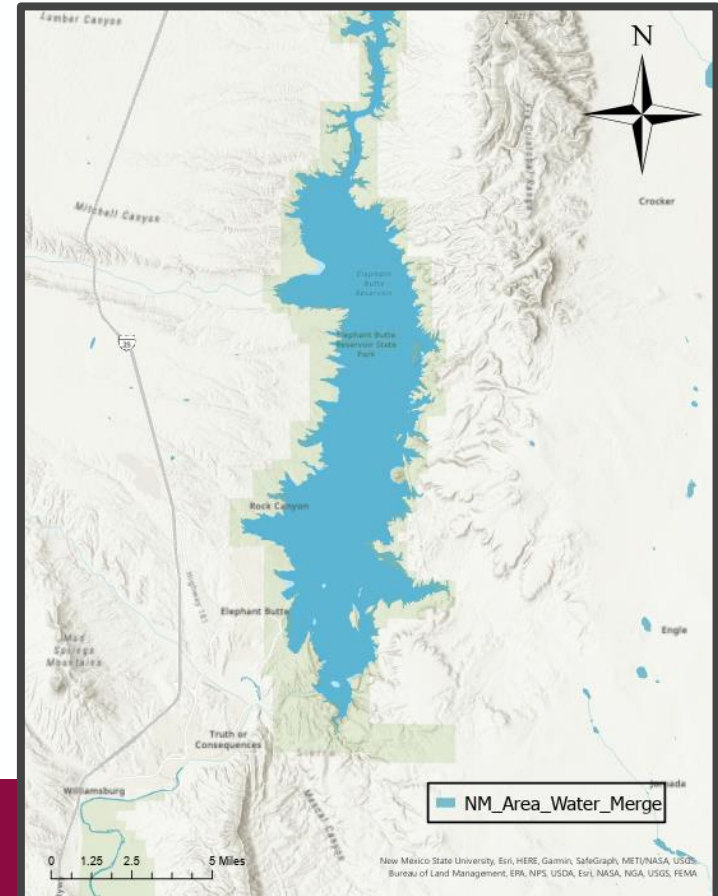
Global Regression / Base Model

- Assumes a homogeneous relationship between selected variables.
 - Fails to identify attenuating effects over distance.
 - Fails to identify spatial variability in the relationships between urban and rural areas.
- A binomial regression was chosen because of overdispersion of the dependent variable



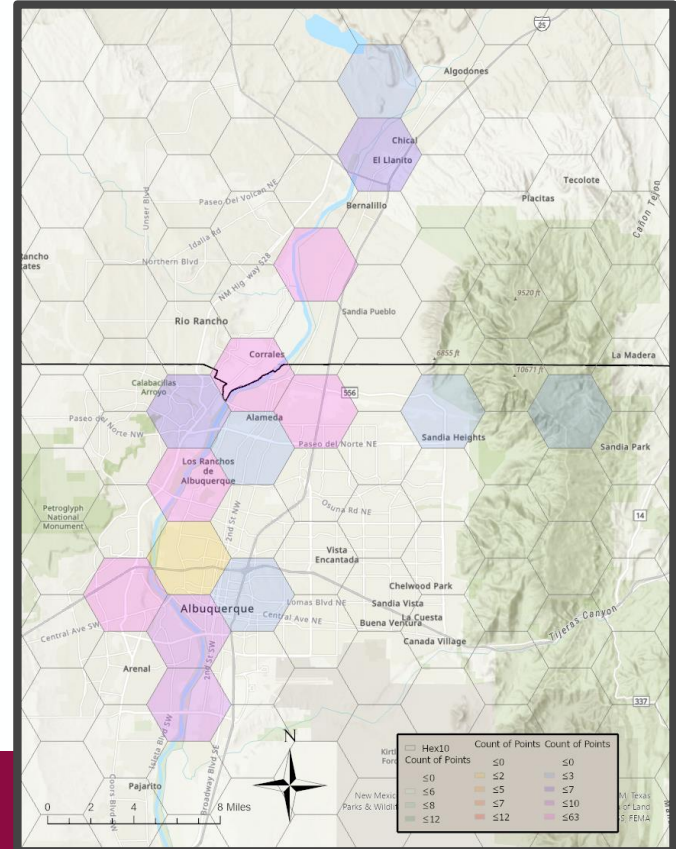
Local Regression / Geographically Weighted Regression (GWR) Model

- Brunsdon et al. (1998) provides an approach that estimates coefficients of variables in distinct geographic locations.
- Used for analyzing data with spatially varying parameters.



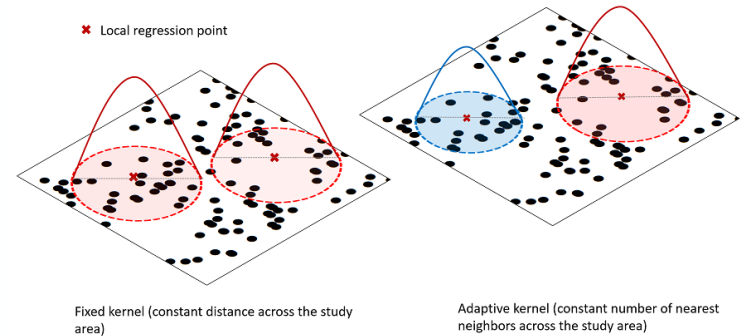
Local Regression / Geographically Weighted Regression (GWR) Model

- GWR creates a model for each specific observation and only includes data from the selected neighborhood of the observation point.
- GWR reveals patterns and solves the spatial homogeneity problem.
- Creates a model for observations using only data in the adaptive kernel of the calibration point.



Local Regression / Geographically Weighted Regression (GWR) Model

- “Data are additionally weighted according to the geographic distance from each data point to the calibration point in such a way that data closer to the calibration point are given more importance than data further away. The result is a set of local models, one at each point, which capture any spatial variability in the relationships” (Tenerelli, 2016).



Source: <https://gistbok.ucgis.org/bok-topics/geographically-weighted-regression-framework>

Local Regression / Geographically Weighted Regression (GWR) Model

- Geographically Weighted Poisson Regression (GWPR) model used.
- Minimum 30 neighbor observations; and maximum 200 neighbor observations.
- Tests the Akaike Information Criterion (AICc) at various distances incrementally between the minimum and maximum neighborhood parameters.
- Gaussian kernel selection attenuates spatial weights in the model as features are located further away from the target feature (ESRI).



Results - Global Model

- 19% of deviance is explained
- AICc of 373.68
- 4 of 12 variables are significant
- Interpretation of results following Tenerelli et. al. (2016) and Fotheringham et al. (2002)
- Some local regression might have limited variation applying weights.

Diagnostics			
Dependent Variable	EVCS		
Number of Observations:	499	Akaike's Information Criterion (AICc)	373.677135
# of observations equal to 1	77	Deviance Explained	0.191781
Joint Wald Statistic	82.322200	>chi-squared, 12 deg. of freedom	0.000000*

Results - Local Model

- Global model improved w/ poisson regression
- GWPR shows a large increase of deviance explained vs. Global
- Global to GWPR comparison shows spatial discord.

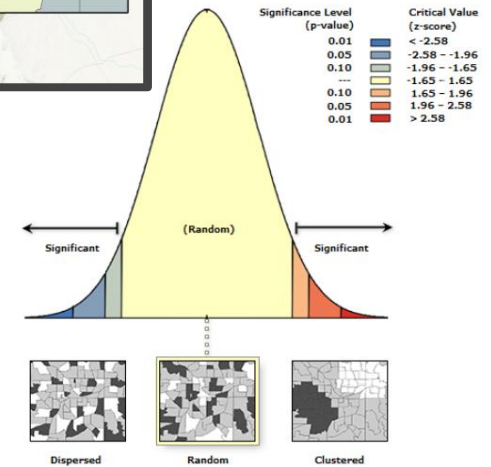
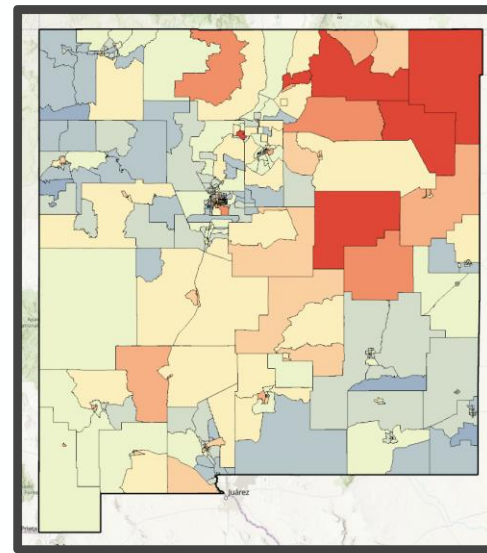
Table 6. Geographically Weighted Poisson Regression Results

Model Diagnostics	
Deviance explained by the global model (non-spatial)	0.3623
Deviance explained by the local model	0.6688
Deviance explained by the local model vs global model	0.4806
Sigma-Squared	19.1550
Sigma-Squared MLE	29.8502
Effective Degrees of Freedom	777.6158
Golden Search Results (Optimum)	
Number of Neighbors	31
Akaike's Information Criterion (AICc)	834.9388

Results

- Spatial autocorrelation assessed using the Moran's I measure.
- Spatial autocorrelation measure based on the locations and features of observations simultaneously.
- Given a set of features and an associated attribute, it evaluates whether the pattern is clustered, dispersed, or random.

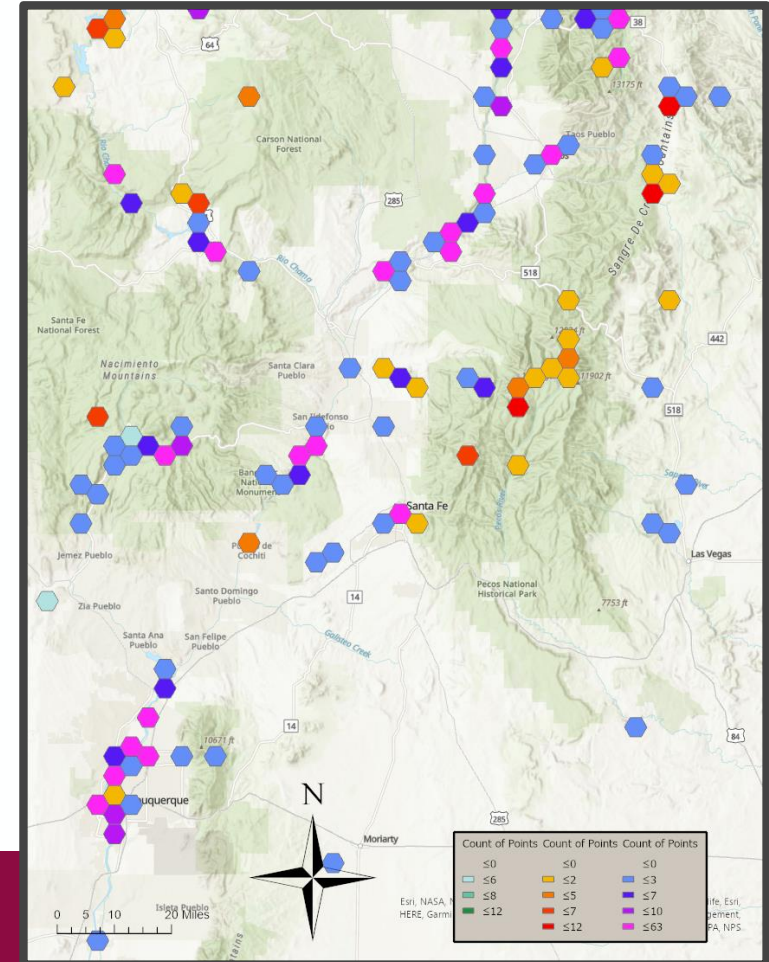
<https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-statistics/h-how-spatial-autocorrelation-moran-s-i-spatial-st.htm>



Given the z-score of -0.05642, the pattern does not appear to be significantly different than random.

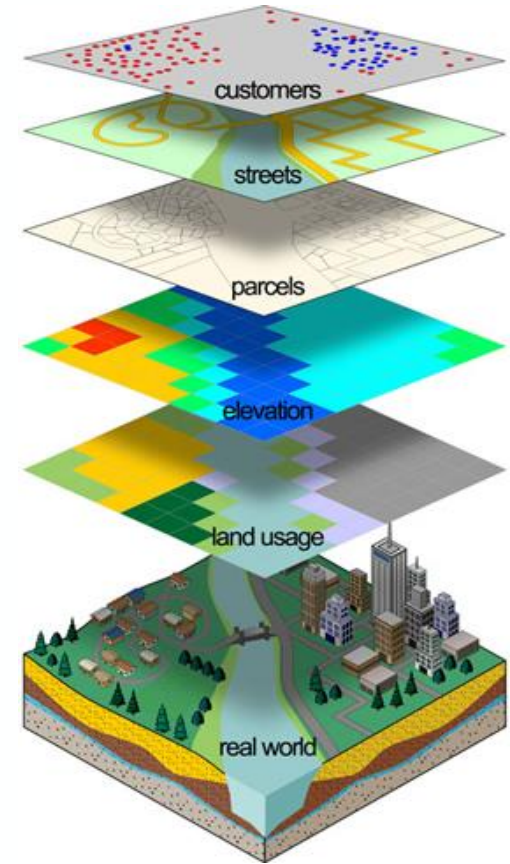
Results

- Global to GWPR comparison shows that spatial variation exists in the data set.
- GWPR has lower autocorrelation and more randomness in its residual values.
- Results indicates the superiority of the localized evaluation method.



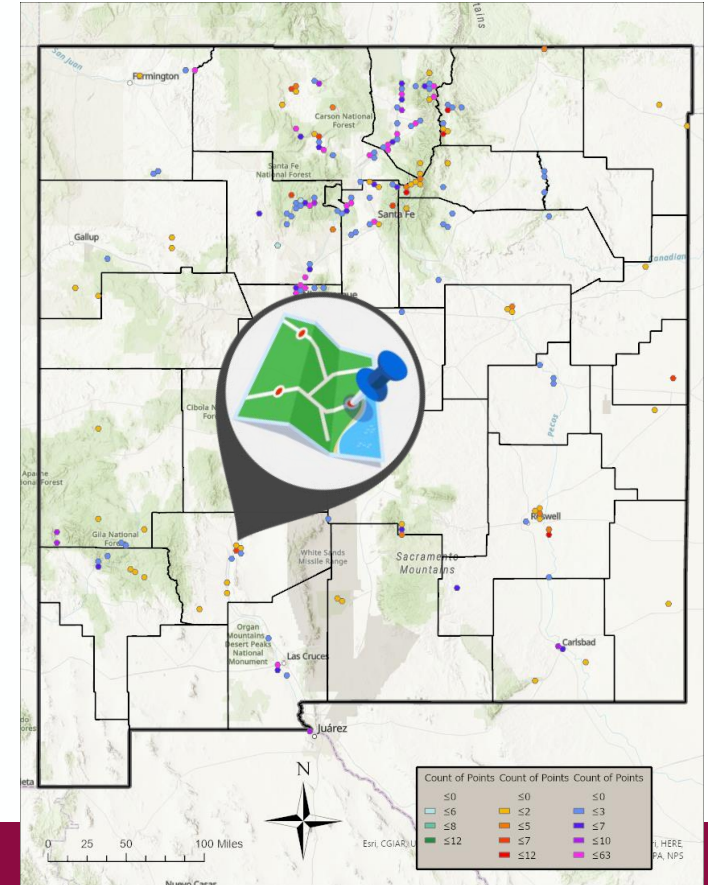
Discussion

- Preliminary modeling technique different from GIS-based MCDM methods previously proposed.
- Spatial heterogeneity is best analyzed with a tool that can identify real world variations between Urban/Rural areas.
- GWR easily integrates with other tools to facilitate a holistic decision process.
- Spatial models can be temporally, computationally, and financially costly to solve. (Soylu et al., 2019)



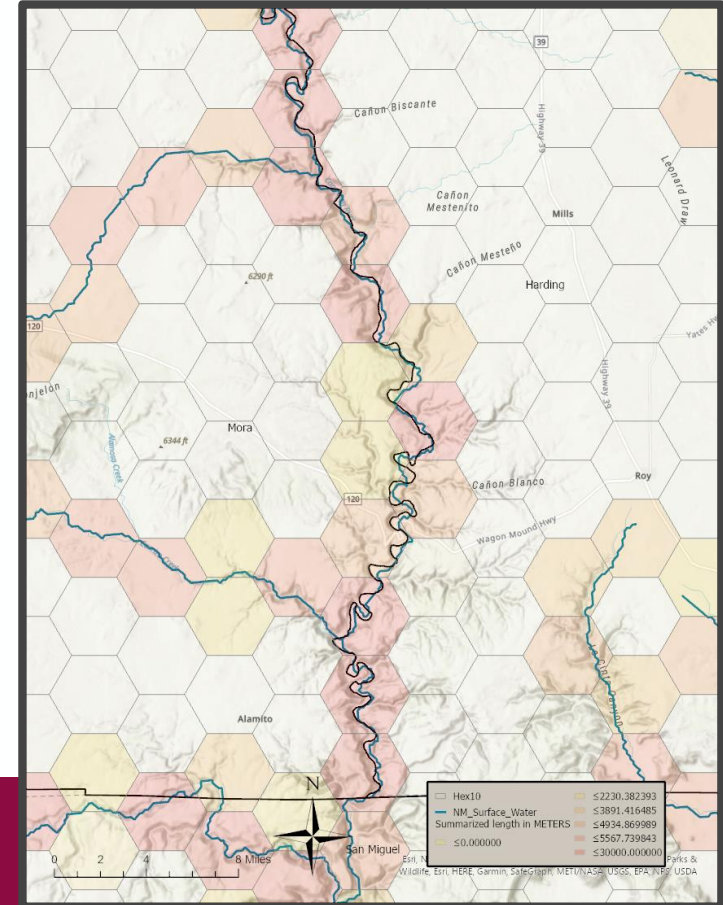
Discussion

- Decision makers must consider specific site variables and examine multiple methods.
- Large residuals can reveal unique geographic unit characteristics.
- Identify areas with over-development or opportunities for water amenity development.
- Water based tourism site improvement processes can be revised.

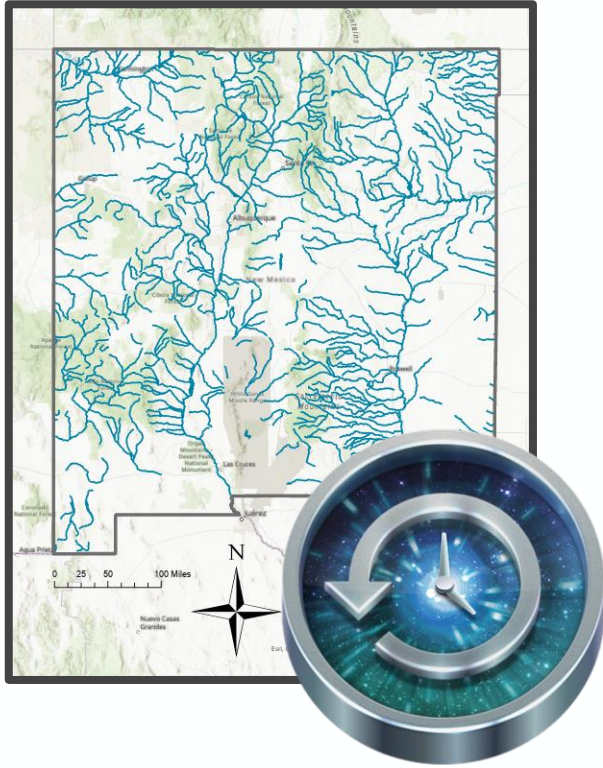


Limitations and Future Research

- Tessellated Hexagons: arbitrary sizes
- Equal qualitative weights for variables
- More relevant with stakeholder/expert inputs.
- Higher quality tourism estimate data.
- Detailed data for the most significant variables; retail, food service, parking, etc.



Limitations and Future Research



- Semi-parametric model: Spatial variability may only be present in some relationships but others are global.
- Evaluate temporal endogeneity with disequilibrium partial-adjustment model
- First Order Queen Contiguity to determine neighborhood structure.
- Robust LaGrange Multiplier to design an appropriate spatial lag.

Conclusions

- No study that I have found explicitly compares rural and urban water tourism site characteristics and relationships using GWR.
- Expansion of outdoor tourism necessitates research that strengthens the decision process for policy makers, captures spatial variability, reduces cost, and is applicable to real-world site funding decisions at both local and regional scales.
- This study analyzes distinct characteristics in New Mexico to identify areas where resources and planning should be directed.





THANK YOU



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