Final Project Report

Title: Opportunities for Maternal and Child Health Interventions in the United States
Notice: Dr. Bryan Runck
Author: Lauren Roach
Date: December 14, 2022

Project Repository: *https://github.com/L-roach/GIS5571/tree/main/Final%20Project*
Google Drive Link: *N/A*
Time Spent: *50 hours*

Abstract
This project aims to address the question: where should public health practitioners and community advocates intervene to improve maternal and child health birth outcomes? By extracting county data on low-birth-weight births, the uninsured rate, the number of primary care physicians, the number of mental health providers, and the number of dentists per 100K residents, a suitability analysis will be conducted to determine which counties have the highest intervention score in the United States. Polygon layers will be converted to rasters, which will be reclassified before the weighted sum tool will be used to create multiple iterations of a suitability raster. The points that repeatedly show up within these rasters will be spatially joined to a county shapefile in order to present a map with the counties needing interventions most highlighted.

Problem Statement
Considering the concerning maternal mortality and morbidity rates throughout the United States, public health practitioners need to explore where interventions are most needed in the country. This requires evaluating and ranking various factors that affect maternal health outcomes. Since health insurance coverage is an important social determinant of maternal health, the uninsured rate should be included in any suitability model. In addition, the number of providers–primary care physicians, mental health providers, and dentists–contribute to health outcomes in an area. Finally, low birthweight can be used as a proxy measure for maternal health outcomes and can also indicate a need for greater maternal care in a particular area, especially when maternal health outcome data are difficult to access. For the purposes of this project, these various factors will be examined at the county level.

Table 1. Data to be included

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	County Health Rankings	Health, demographic, and provider information by county 2022	N/A	%, counts	2022 CHR	N/A
2	County shapefiles	United States County boundaries	Polygon	shapefile	Census	N/A

Input Data
Because health data can be difficult to source at scales needed for a suitability analysis, and consistent across counties, data for this project will be sourced from the County Health Rankings 2022 (CHR). CHR collects data from a myriad of sources and compiles the data at the county level for public access and use. There are five variables that will be used for this suitability analysis.

Table 2. County Health Rankings Data

#	Title	Purpose in Analysis	Link to Source
1	Low birthweight	*Health Outcomes:* Percentage of low birthweight births in each county from the National Vital Statistics System (NVSS)	CHR
2	Mental Health Providers	*Access to Care:* Number of mental health providers per 100K in each county from the National Plan and Provider Enumeration System (NPPES)	CHR
3	Dentists	*Access to Care:* Number of dentists per 100K in each county from the Area Health Resource File of the US Department of Health and Human Services	CHR
4	Primary Care Physicians	*Access to Care:* Number of primary care physicians per 100K in each county from the Area Health Resource File of the US Department of Health and Human Services	CHR
5	Uninsured	*Access to Care:* Percentage of the population uninsured in each county from the US Census Bureau's Small Area Health Insurance Estimates (SAHIE)	CHR

Methods
To conduct a suitability analysis to identify counties most needing intervention to improve maternal and child health outcomes, the data first needed to be requested from the ArcGIS Living Atlas and inputted to the map. The data needed only minimal cleaning to identify the layers that would be used for creating the rasters for the analysis. Once the variables were extracted, the polygon layers were converted to rasters using the polygon to raster tool.

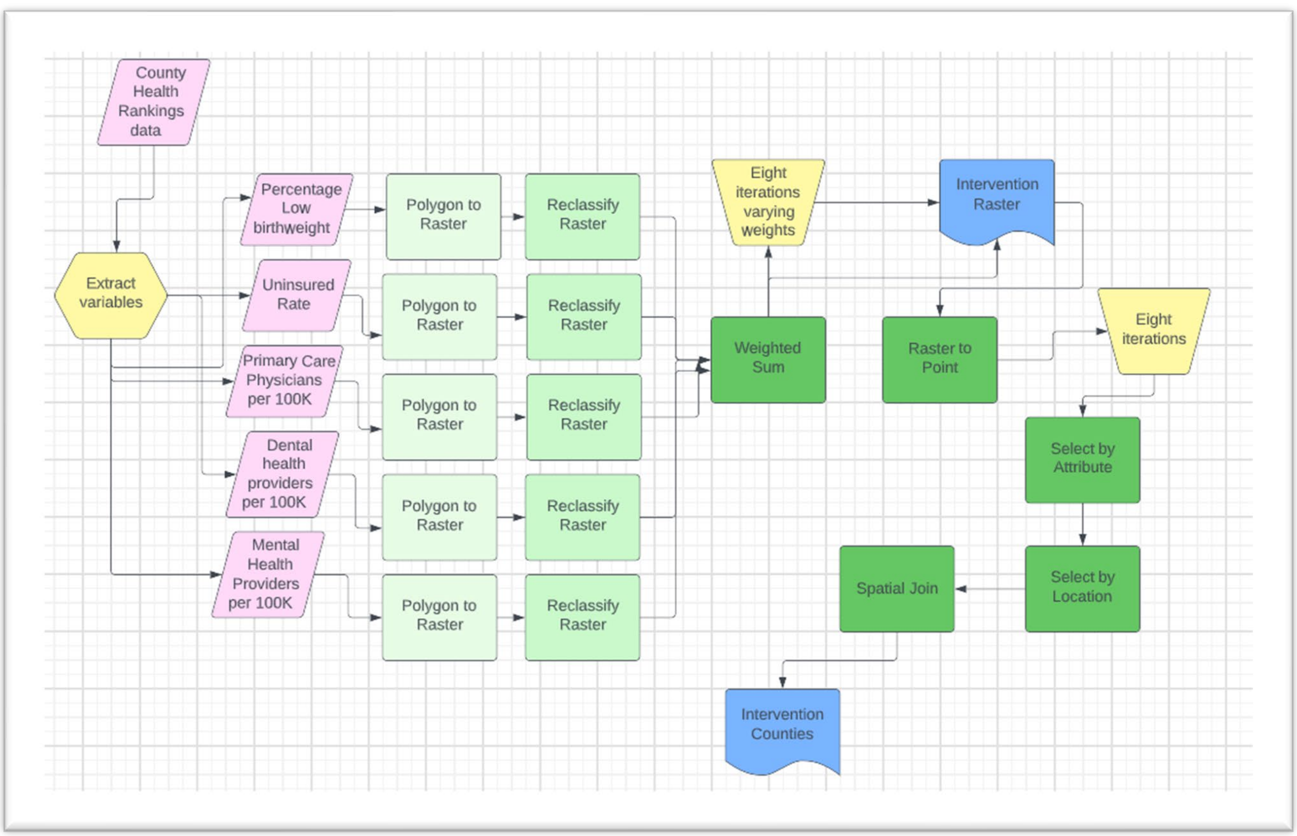
From there, each raster was reclassified to a 1-10 scale. Higher values corresponded to areas with fewer providers and a higher percentage of low birthweight births. The reclassified rasters were then used to complete multiple iterations of a weighted sum raster. In total, eight weighted sum rasters were created using different weights between the five variables (Table 3).

Since low birthweight births is a proxy for maternal and child health in this suitability analysis and a significant measured outcome, this received greater weight in three of the rasters. However, one raster was created with equal weights among all variables. Then the highest weight was iterated through the variables, essentially each variable taking a turn with the greatest weight. Finally, the last weighted sum raster was created with equal weights between low-birth-weight births and dentists per 100K because these are both associated with negative maternal and child health outcomes.

In order to select the highest value areas, these eight rasters were converted from raster to point layers. Then, the points with a value above 7 on a 1-10 scale were selected using the selection by attribute tool. After selection, these selected points were exported to a new feature layer. These eight feature layers were used to select the points that occurred in all layers with the select by location tool. The select by location points were exported to a new feature layer and represented the points with the greatest values no matter the weights used in the weighted sum.

Once the highest value points were selected and exported to a new feature layer, these points were spatially joined to the county layer. Then the joined county layer was symbolized with graduated colors to show the counties with the highest values. These counties are the counties that have the highest percentage of low birthweight births, fewest providers, and highest uninsured rates in the United States, no matter how the rasters are weighted.

Figure 1. Data flow diagram.



Results

The reclassified rasters for each of the five variables are shown below (Figure 2-6).

Figure 2. Percent Low Birth Weight Births Reclassified Raster

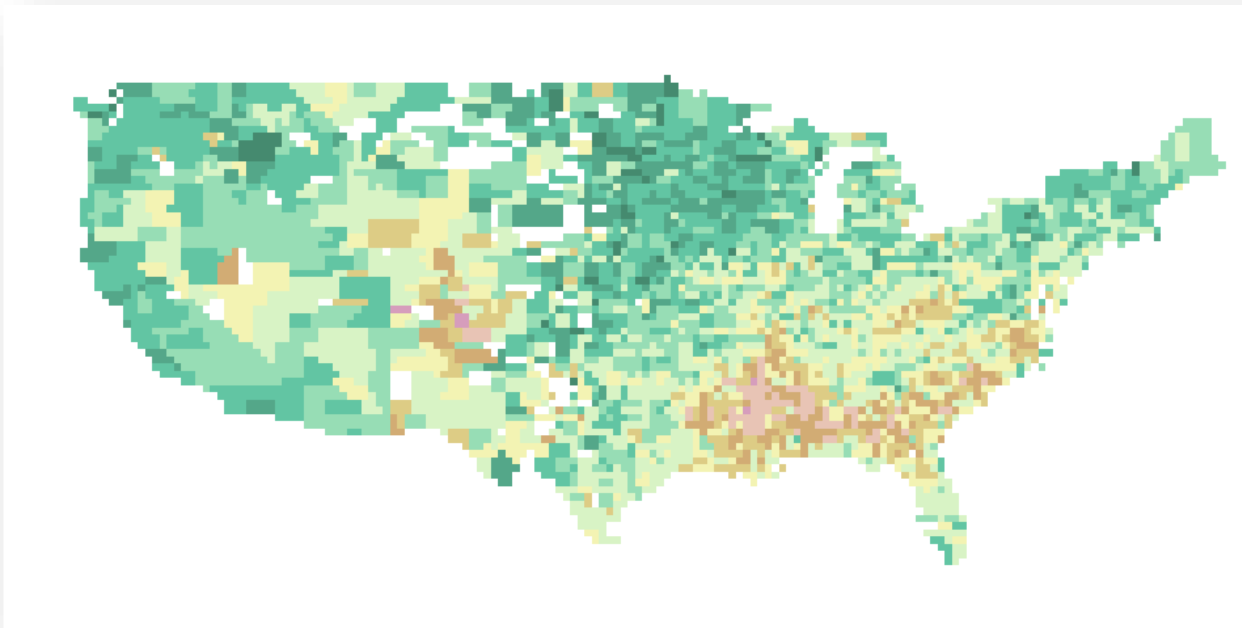


Figure 3. Uninsured Rate Reclassified Raster

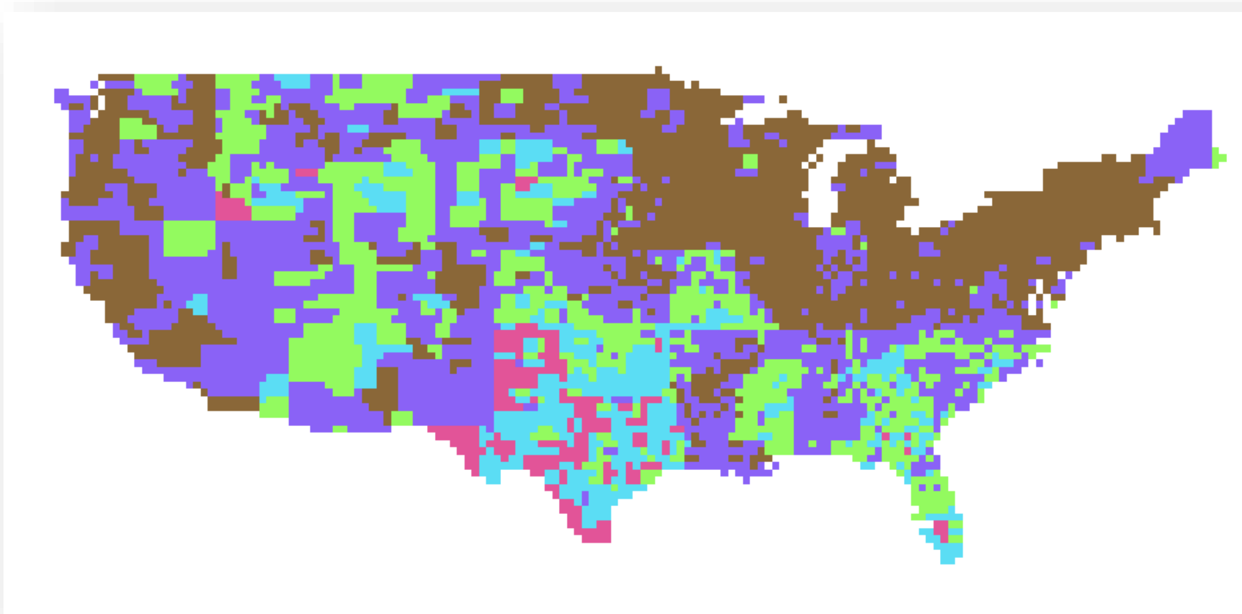


Figure 4. Dentists per 100K Reclassified Raster

Figure 5. Mental Health Providers per 100K Reclassified Raster

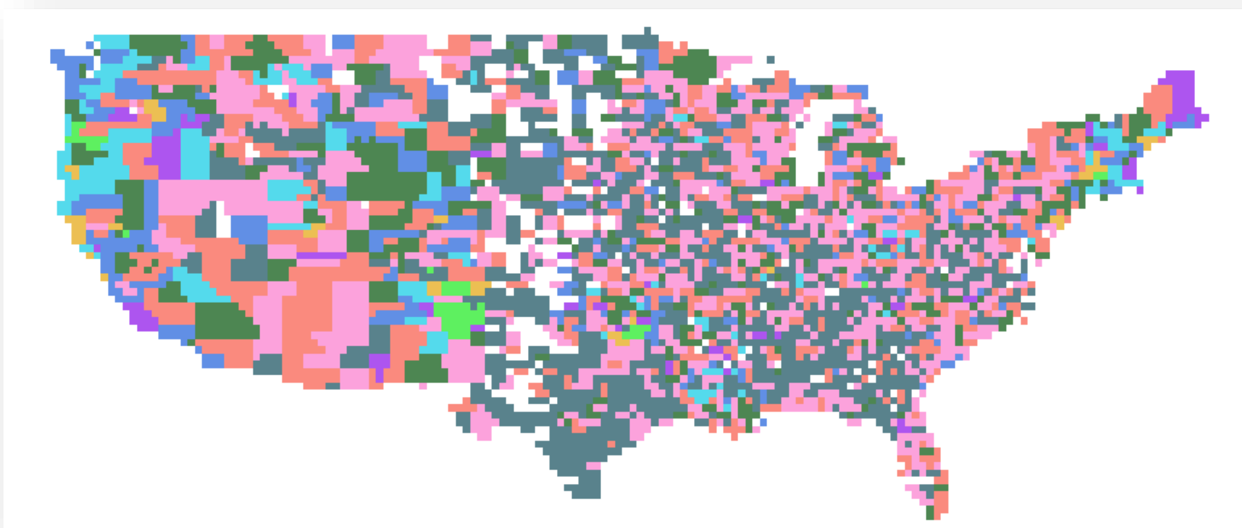
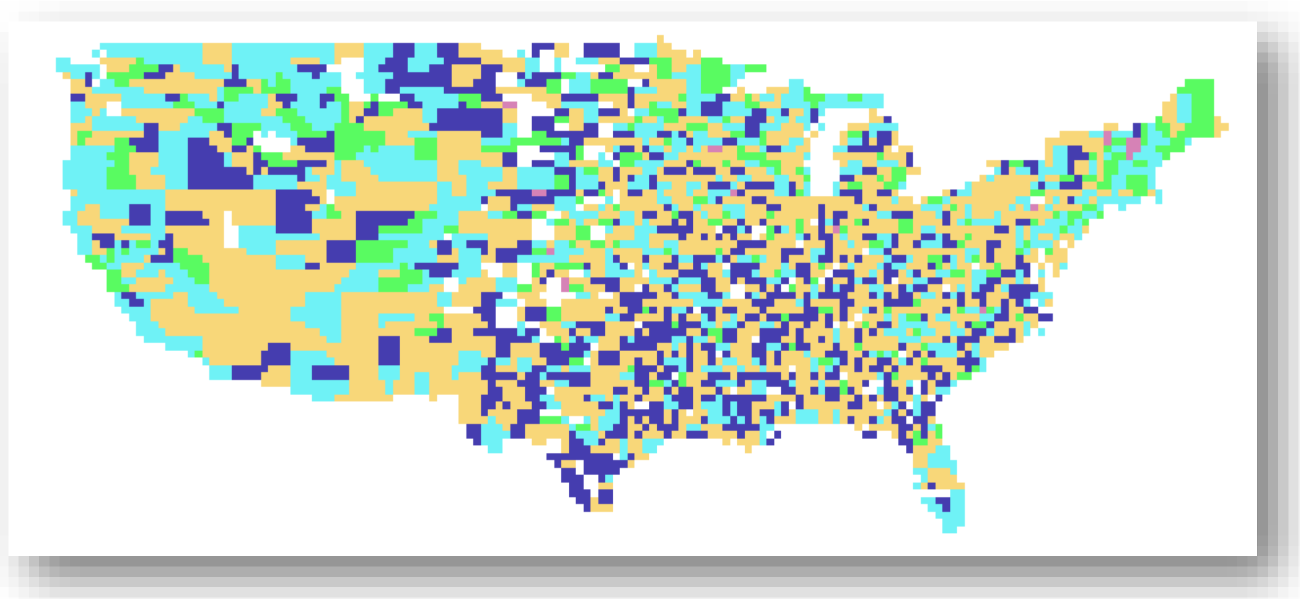
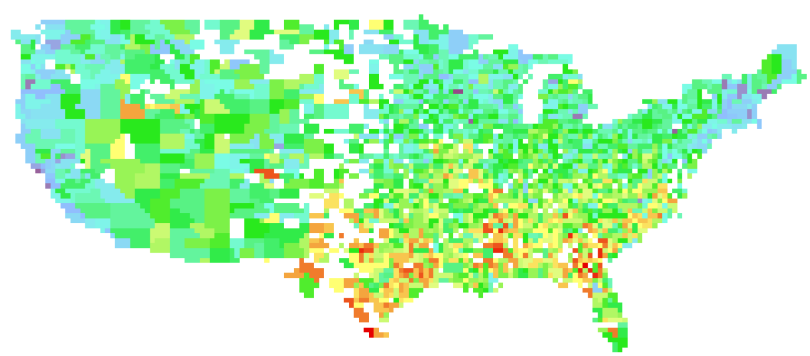


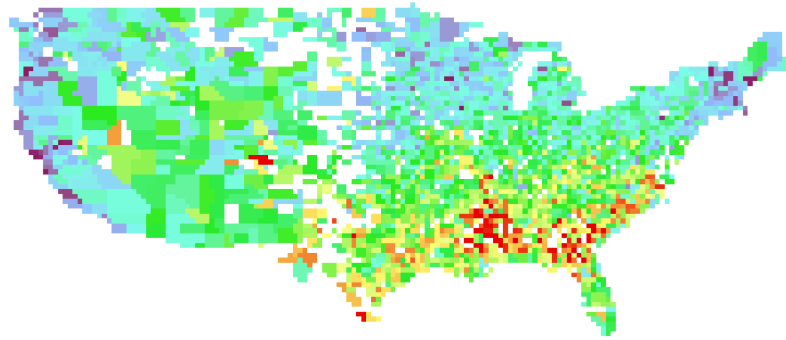
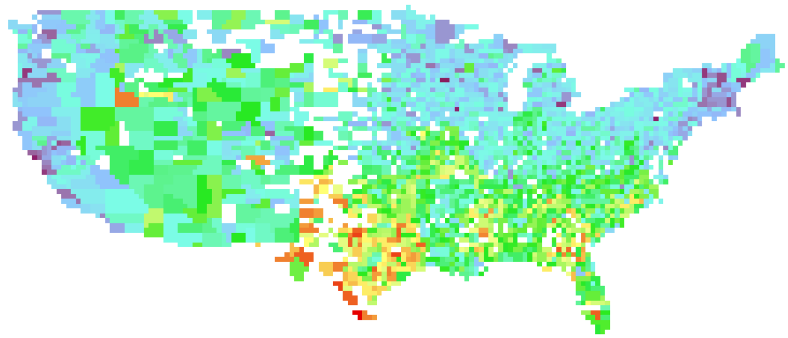
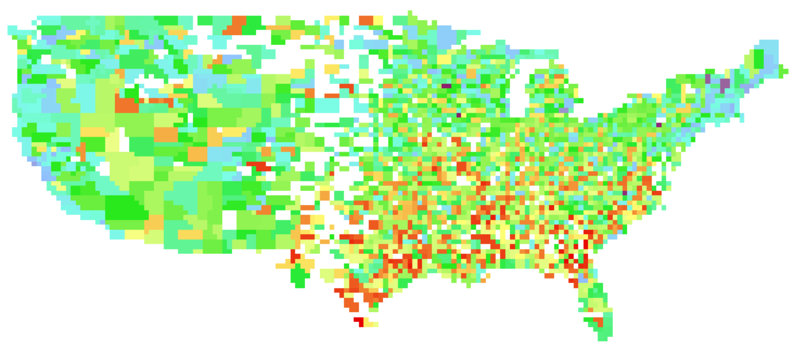
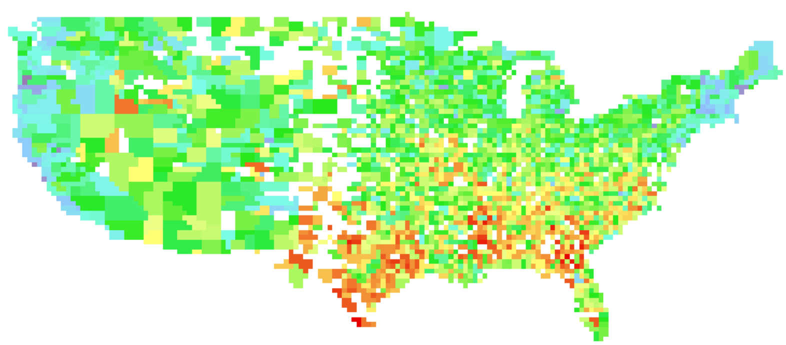
Figure 6. Primary Care Physicians per 100K Reclassified Raster



Eight weighted sum raster was created with various weights combining these five factors to create suitability rasters (Table 3). The upper east and west coast lines consistently rate low on the intervention scale, depicted in the blue purple counties. The central United States consistently contains a lot of green, which indicates a mid-intervention score. The south and southeast portion of the country consistently has varying degrees of yellow, orange, and red, demonstrating that counties with high intervention scores are consistently located in this area but shift in severity across the different weighted rasters. For example, in raster #1 Texas, Louisiana, and Florida have lots of red counties, i.e., high intervention scores, while in raster #7 red counties are concentrated in Mississippi, Alabama, and Georgia.

Table 3. Weighted Sum Raster Comparison

#	*Weights*	*Map*
1	Equal weights for all variables: 0.2 for all.	

2	Low birth weight births weighted at 0.4, all others at 0.15.	
3	Uninsured rate weighted at 0.4, all others at 0.15.	
4	Dentists per 100K weighted at 0.4, all others at 0.15.	
5	Mental health providers per 100K weighted at 0.4, all others at 0.15.	

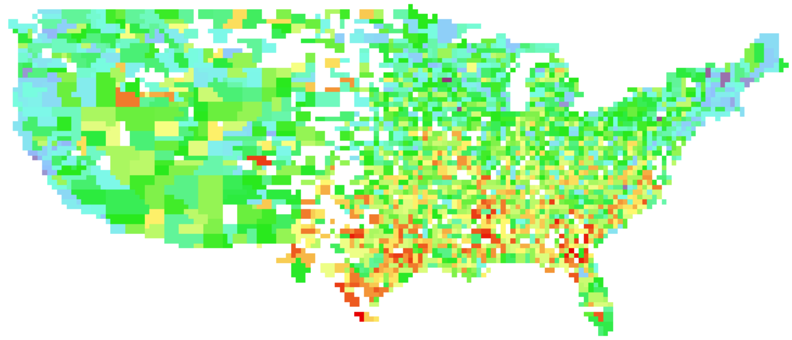
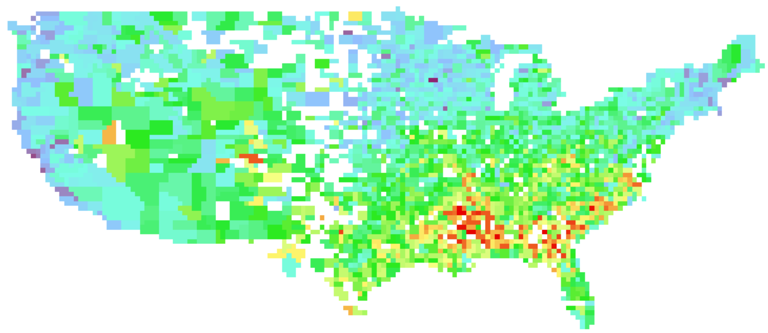
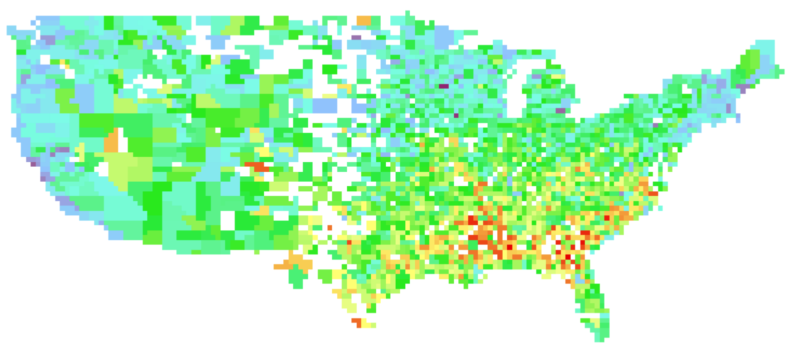
6	Primary care physicians per 100K weighted at 0.4, all others at 0.15.	
7	Low birth weight births weighted at 0.4, dentists per 100K weighted at 0.3, all others at 0.1.	
8	Low birth weight births weighted at 0.35, dentists per 100K weighted at 0.35, all others at 0.1.	

Figure 7. Highest value points that occurred in all weighted sum rasters

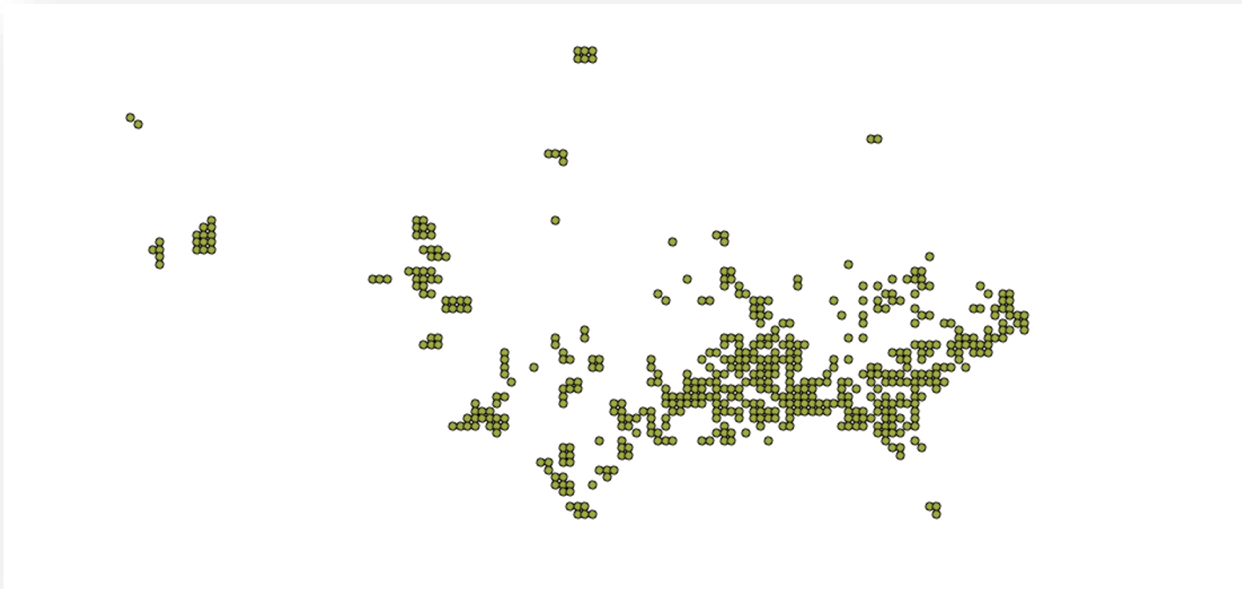


Figure 8. Points needing intervention spatially joined to the counties

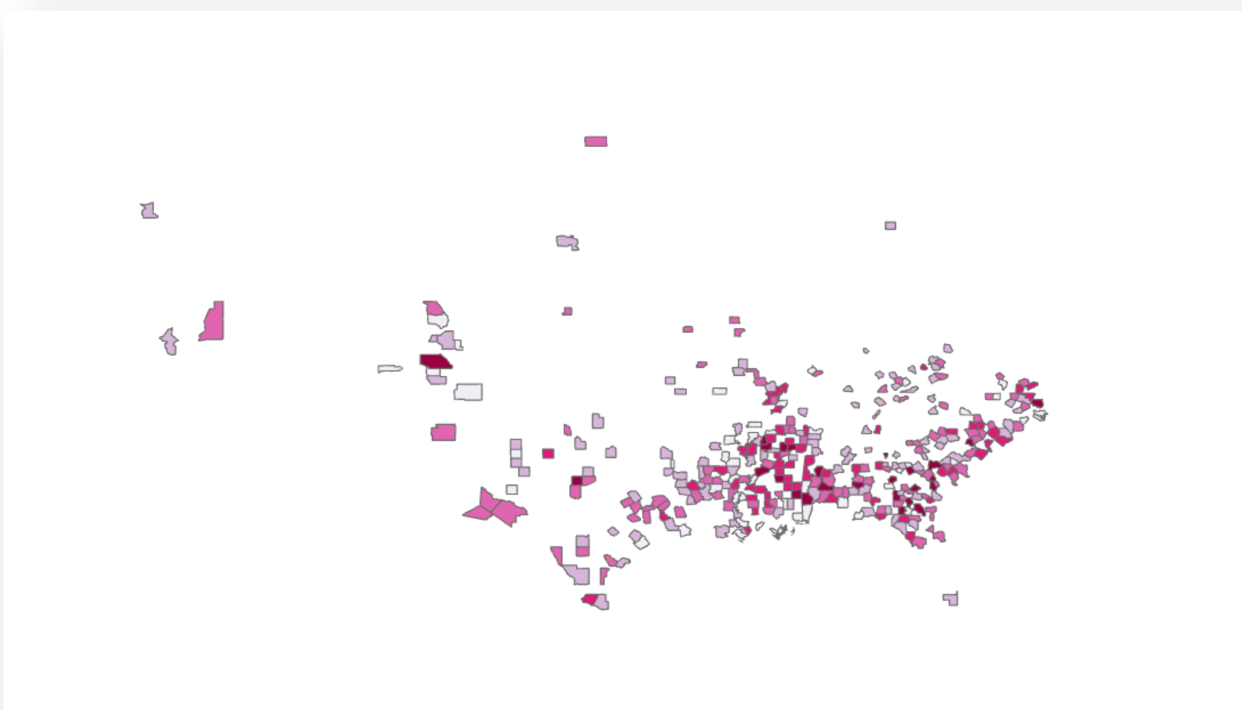
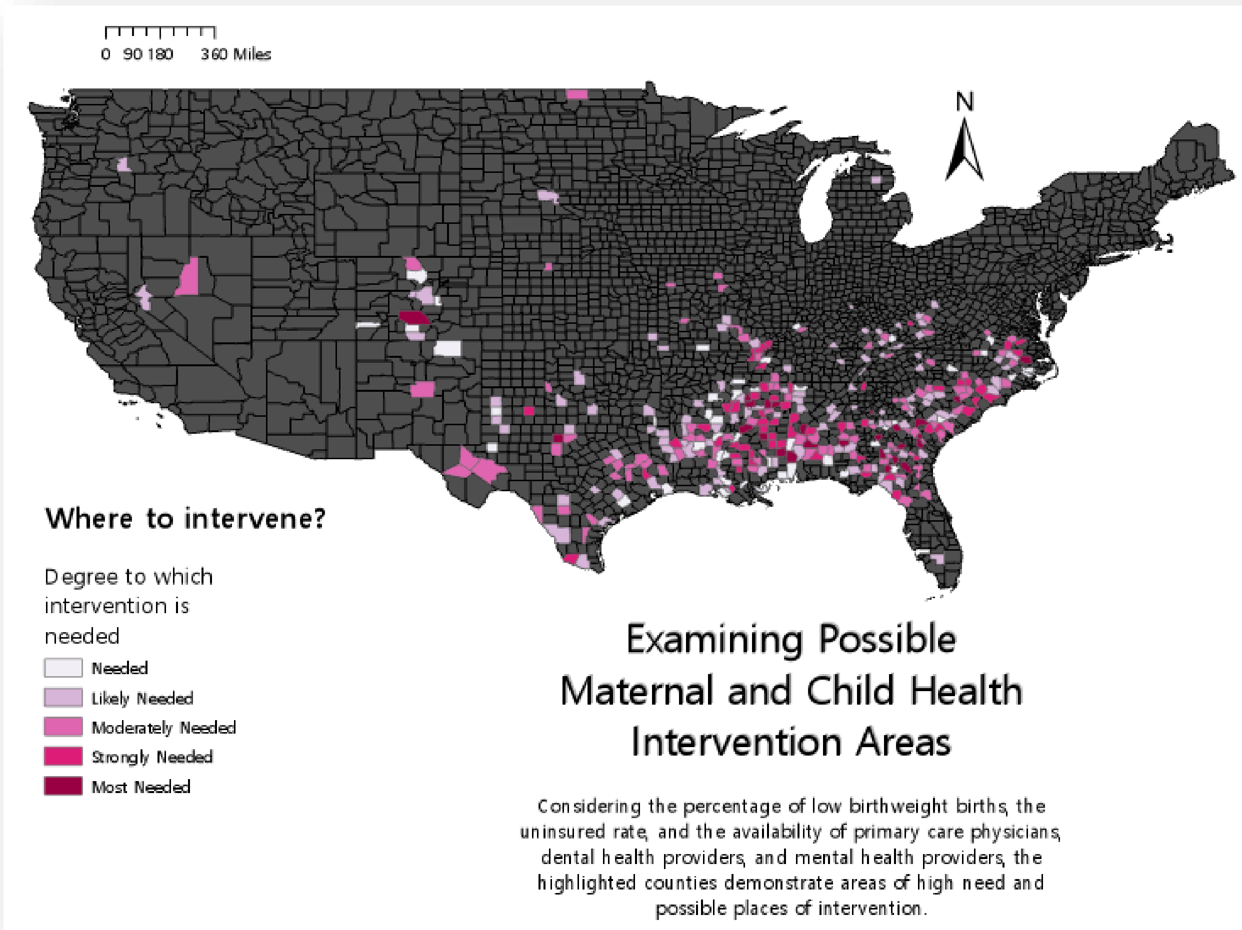


Figure 9. Counties needing intervention



Results Verification

A sensitivity analysis was performed that involved removing one of the counties and re-running the analysis in turns. Considering the results of the sensitivity analysis were similar to the results from the weighted sum aggregation, this indicates that the results are valid, albeit only a few variables were included in this analysis.

Discussion and Conclusion

The final polygon layer created indicates which counties in the United States are most in need of intervention regarding maternal and child health outcomes related to birth. Yet, it is important to note that this analysis is significantly limited because it only accounts for low-birth-weight births and the uninsured rate, with the amount of dentists, primary care physicians, and mental health providers per 100K residents in each county. Future suitability analyses should incorporate obstetrics information per 100K residents in each county and other maternal health measures that are collected at the county level.

Even so, this analysis demonstrates that there is a significant need for maternal and child health interventions in the southeast of the United States. These counties have a high percentage of low-birth-weight births and residents who are uninsured, as well as low access to primary care physicians, mental health providers, and dentists per 100K residents. The highlighted counties in this analysis are concentrated in states like Texas, Louisiana, Mississippi, Alabama, Georgia, Florida, South Carolina, and North Carolina, indicating that public health practitioners should investigate how best to aid interventions in these areas, support current programs, and sponsor new ones in this region.

References

Anil, K., Basel, P., & Singh, S. (2020). Low birth weight and its associated risk factors: Health facility-based case-control study. *Plos One* 15(6).

Committee on health care for underserved women. (2022). Oral health care during pregnancy and through the life span. *The American College of Obstetricians and Gynecologists.*

Gordon, S., Sugar, S., Chen, L., Peters, C., Lew, C., Sommers, B. (2021). Medicaid after pregnancy: State-level implications of extending postpartum coverage. *ASPE Office of Health Policy* (28).

DHS Program. (2014). Health insurance coverage and its impact on maternal health care utilization in low and middle income countries. *Maternal Health*.

Editors. (2019). Dentists can help improve maternal and fetal health. *The Journal of Multidisciplinary Care.*

Hack, M., Klein, N., & Taylor, H. (1995). Long-term developmental outcomes of low birth weight infants. *Future Child* 5(1):176-196.

Mayberry, M. Gonik, B., Trombly, R. (2020). Perinatal oral health: A novel collaborative initiative to improve access, attitudes, comfort level, and knowledge of pregnant women and dental providers. *American Journal of Perinatology* 10(1): 54-61.

Solomon, J. (2021). Closing the coverage gap would improve black maternal health. *Center on Budget and Policy Priorities*.

Self-score
Fill out this rubric for yourself and include it in your lab report. The same rubric will be used to generate a grade in proportion to the points assigned in the syllabus to the assignment.

Category	Description	Points Possible	Score
Structural Elements	All elements of a lab report are included **(2 points each)**: Title, Notice: Dr. Bryan Runck, Author, Project Repository, Date, Abstract, Problem Statement, Input Data w/ tables, Methods w/ Data, Flow Diagrams, Results, Results Verification, Discussion and Conclusion, References in common format, Self-score	28	**28**
Clarity of Content	Each element above is executed at a professional level so that someone can understand the goal, data, methods, results, and their validity and implications in a 5 minute reading at a cursory-level, and in a 30 minute meeting at a deep level **(12 points)**. There is a clear connection from data to results to discussion and conclusion **(12 points)**.	24	**22**
Reproducibility	Results are completely reproducible by someone with basic GIS training. There is no ambiguity in data flow or rationale for data operations. Every step is documented and justified.	28	**26**
Verification	Results are correct in that they have been verified in comparison to some standard. The standard is clearly stated **(10 points)**, the method of comparison is clearly stated **(5 points)**, and the result of verification is clearly stated **(5 points)**.	20	**20**
		100	**96**