Pharmacy Accessibility in Iowa

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Introduction

Pharmacies and access to them are critical for a community's livability, health, and overall quality of life. Pharmacies give access to medications that are essential and they support both preventive care and ongoing treatment for conditions that are chronic. That being said, however, access to these essential resources is not always distributed evenly across communities, and disparities are often reflected in socioeconomic and geographic inequities. My project is examining the accessibility of pharmacies in Iowa, it will specifically focus on vulnerable groups and socioeconomic conditions. Population density and transportation networks. These were the main questions that I focused on for this project:

1. Where are pharmacies relative to population density and elderly residents?
2. Do counties who are lower income have fewer pharmacies per 10k people, creating access that is uneven to receiving essential medications and treatments?
3. How do hazard zones affect road by county?
4. Do the affected counties in question three correlate with median income?

It is important to look at these questions at county scale because access to these facilities can vary within geographic areas that are small. State-wide averages may suggest that there is overall great pharmacy availability but more localized shortages can persist still in lower-income or rural areas as well as lack enough pharmacies in certain communities with very high concentration of residents that are elderly. When I examined the data at the county level it helped to reveal inequities and informed me on the communities that need targeted strategies to improve their access to healthcare.

Socioeconomic and demographic context and information is the center of this project. Individuals who are elderly or low-income rely more heavily of pharmacies that are nearby for medication access that is timely, when these groups of people live in areas where there are less

pharmacies their outcomes of health are directly affected. By using demographic variables (age, income) this project shows where the people who are in more need also have few pharmacies nearby.

When looking beyond these spatial patterns this project helps to provide insight for people who can make a difference for underserved communities. People like local officials, public health planners, healthcare providers and different organizations that help the community.

These people can use county-level data to identify gaps in service to these communities and prioritize locations for new pharmacies, and with the road network maps help plan for emergency situations such as flooding. My results with hopefully help planning of healthcare delivery. Overall this project is an assessment of pharmacy accessibility across the state of Iowa . By looking at spatial analysis and socioeconomic and demographic context. It shows areas where there are adequate access to pharmacies and region that face challenges.

Methods

I used four data sources plus a few sources to help guide me through this assignment. The first data source I used was the U.S Census Bureau's Tiger/Line Shapefiles which gave me geographic data that was essential for my spatial analysis. The second was the FEMA's flood map which helped me to identify areas that were flood prone. The third was IGISMAP's pharmacy data that helped me to identify pharmacy locations, and the fourth was the Iowa DOT open Data portal which gave me a great road network dataset that helped me identify which roads were affected by flood hazards.

The first question I focused on was *"where are pharmacies relative to population density and elderly residents?".* I first needed to clean and standardize my raw datasets to make sure that

they were consistent with county names and other geographic identifiers. I combined population density and income levels, and age into a single dataset at the county level. I then went and added county information in an excel spreadsheet to the pharmacy dataset and then using excel to figure out how many pharmacies were in each county; I then added it back to ArcGIS and joined it to that joined dataset. I then calculated new metrics such as pharmacies per ten thousand residents, and I isolated elderly population percentages per county.

To visualize these relationships, I created multiple choropleth maps showing population density and elderly population percentages by county and I overlaid those with pharmacy location points. This made it so I could compare and identify geographic disparities, such as counties with a high elderly population but limited pharmacies nearby. Which gave me the insight into potential gaps in healthcare access.

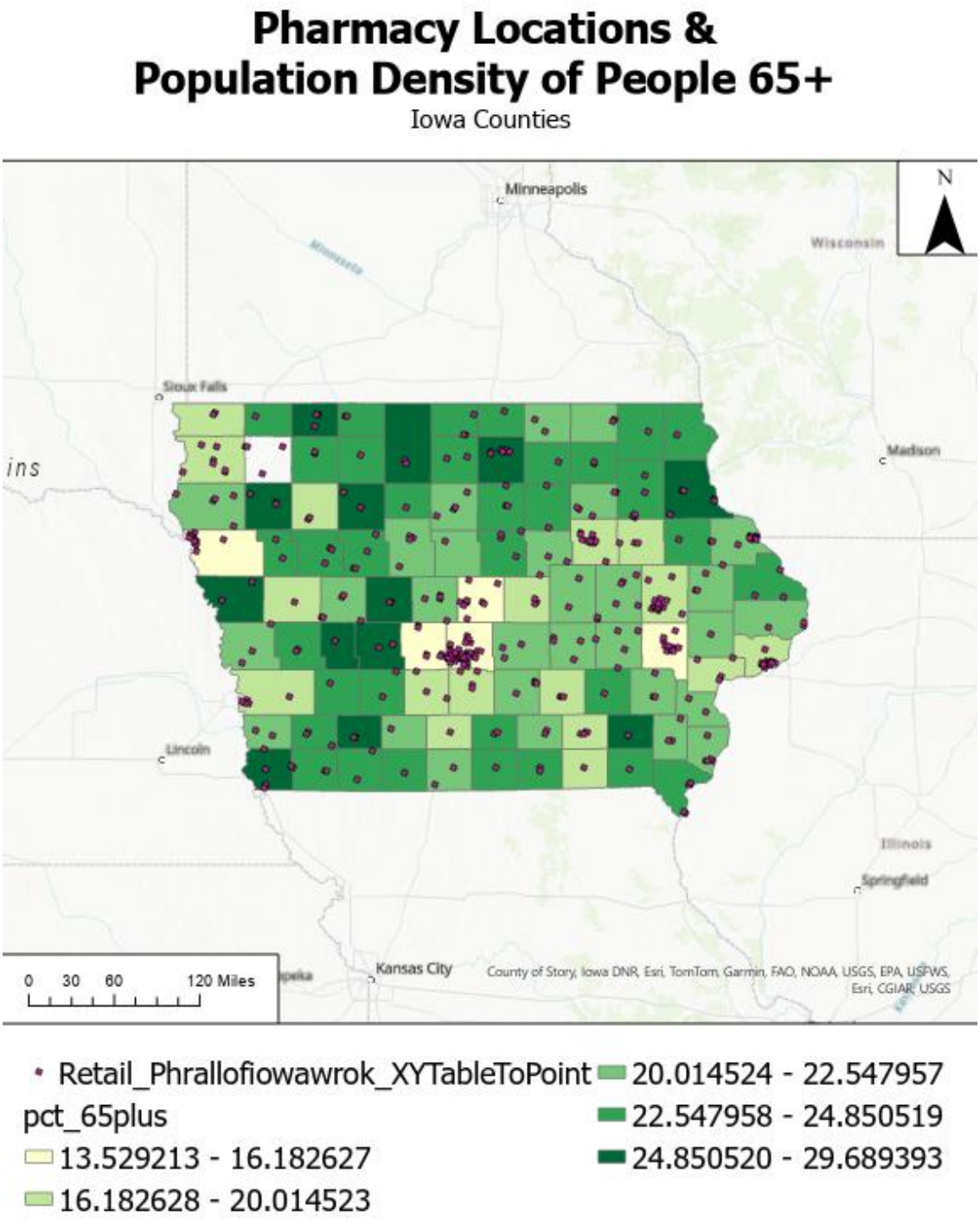
For my second question I first needed to determine whether median income correlated with counties that had few pharmacies per ten thousand individuals. I merged pharmacy location data and county level economic information, such as median household income. I computed a peason correlation on excel that compared median income and pharmacies per ten thousand residents to quantify the relationship. I created a bivariate map that combined income and pharmacy density per ten thousand people to identify where lower income counties coincide with pharmacy access that is limited.

For my third question I looked at flood hazard zones affect roads, and how many roads are affected per county. I first combined my flood hazard zones and my road network by spatial join and county boundaries by spatial join. I then used summarize within to summarize how much of the roads were affected by length (km) and a count if impacted segments per county. I then normalized fields such as affected road density. To visualized the total kilometers of flood

affected roads I mapped with a graduated color choropleth map. This visual showed clusters of higher exposure and highlighted that rural counties had sparse alternative routes.

For my fourth question, which was if the affected counties in question three correlate with median income, I joined the county flood-expire metrics to the median household income at a county level metric. I made a bivariate choropleth (Flood Exposure × Median Income) to visualize where lower income and high exposure overlap.

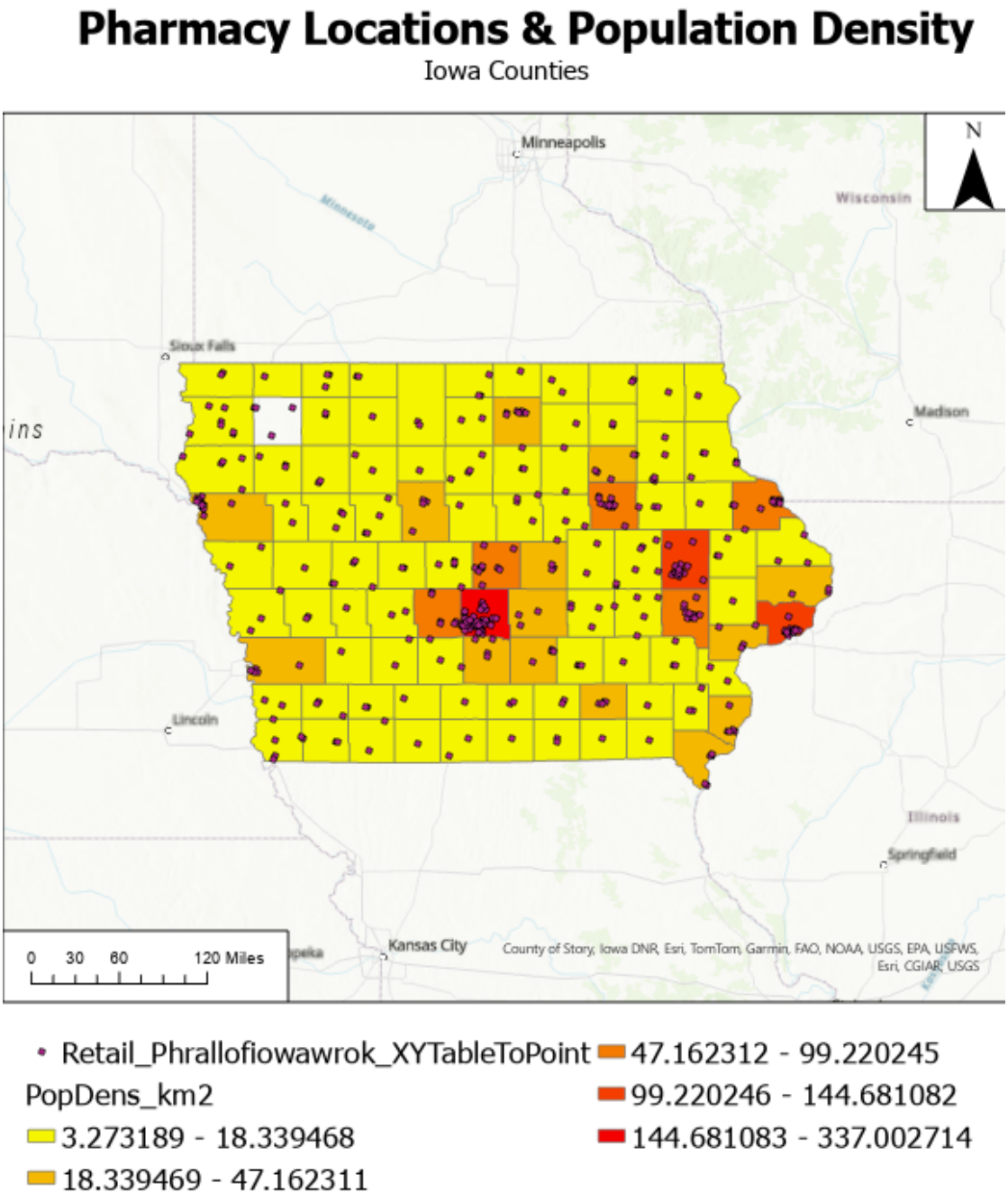
RESULTS



Map 1: Pharmacies and Elderly Population Density

This Map shows how pharmacies across Iowa counties are distributed in relation to the percentage of residents that are sixty-five and older. The darker green shaded counties have a higher percentage of elderly residents, while the lighter green shows lower percentages of elderly

residents. Pharmacy locations are represented as purple dots. They are clustered in areas that are more urban which leave rural counties with high elderly populations underserved.



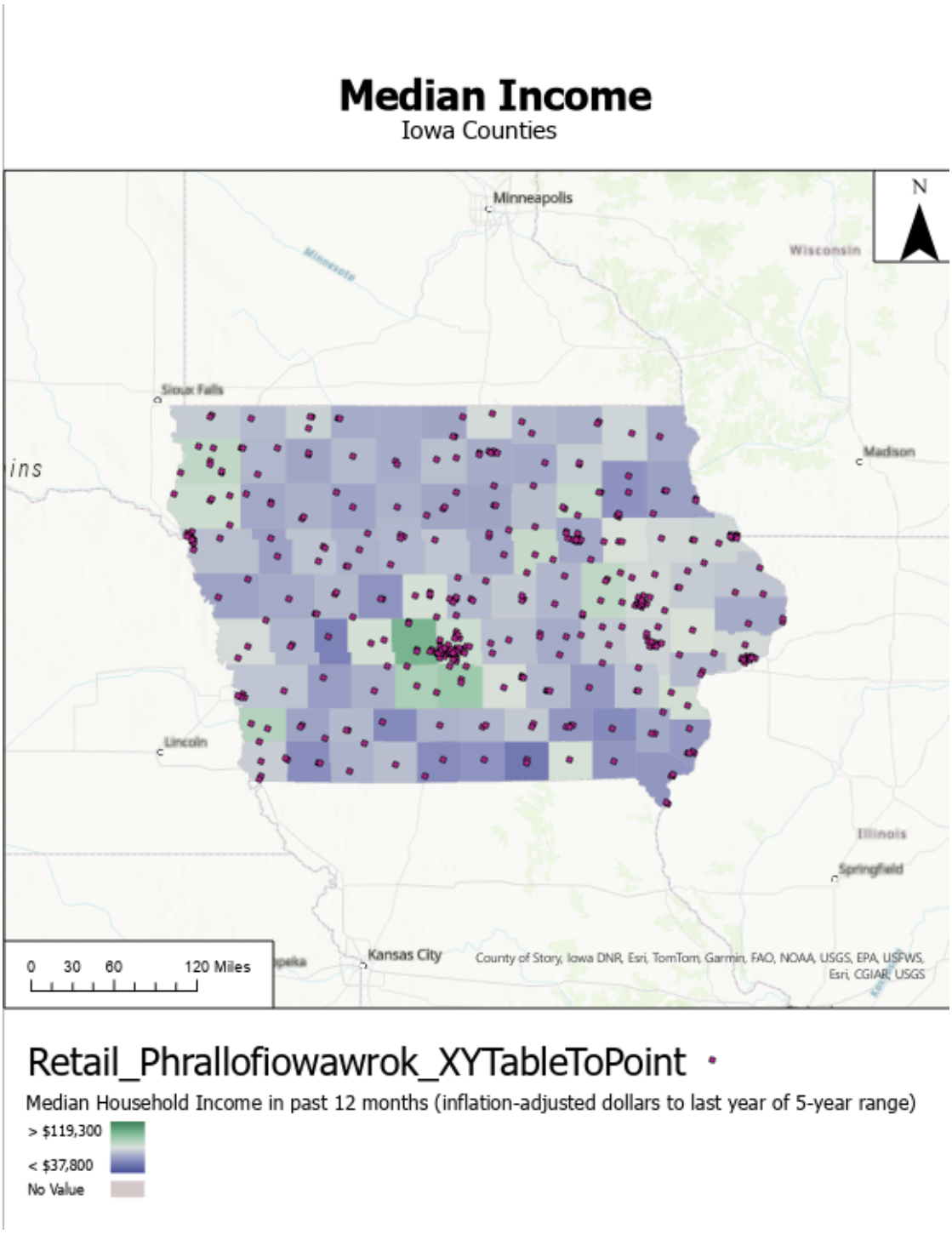
Map 2: Pharmacy Locations Relative to Overall Population Density

This map visualized locations that are relative to population density overall. The counties are shaded from light yellow to dark red. The light yellow being low density of people and dark red being a high density of people. The pharmacies are shown as purple dost and they are concentrated in areas that have higher population density such as central and eastern Iowa.

Pearson Correlations
Median Income vs. Pharmacies per 10k
-0.19607

Table 1: Do lower-income counties have fewer pharmacies per 10,000 people, creating uneven access to essential medications?

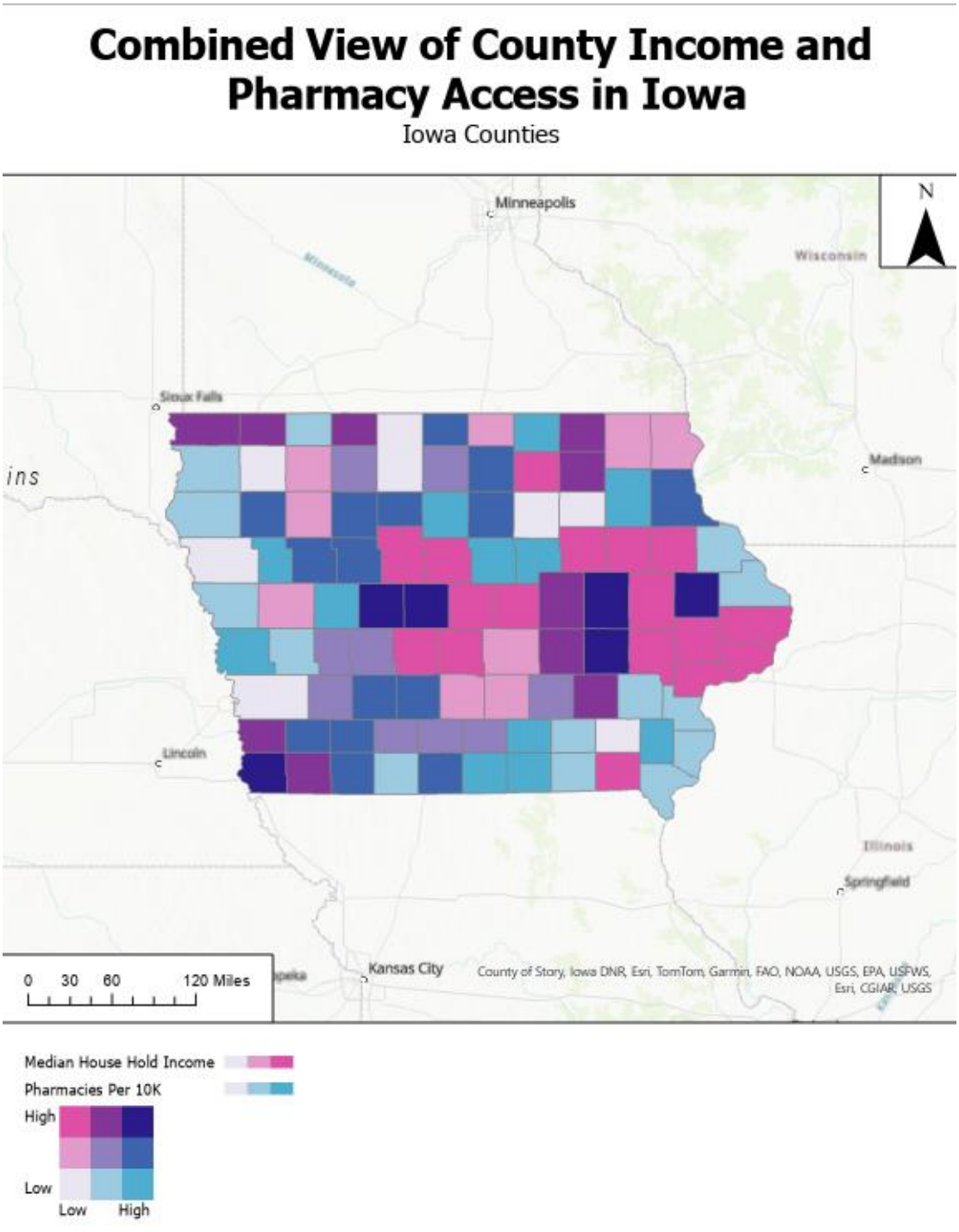
This table shows a Pearson correlation that is –0.10607 which shows a median income and pharmacies per 10,000 people. This number means as a county income decreases the number of pharmacies per 10,000 people tends to increase slightly.



Map 3 : Do lower-income counties have fewer pharmacies per 10,000 people, creating uneven access to essential medications?

This map shades counties by the median household income. Green is higher income and blue is lower income and pharmacies are purple dots. This map suggests that there is a mixed patter. Urban counties often tend to have a higher income, host clusters of pharmacies. However,

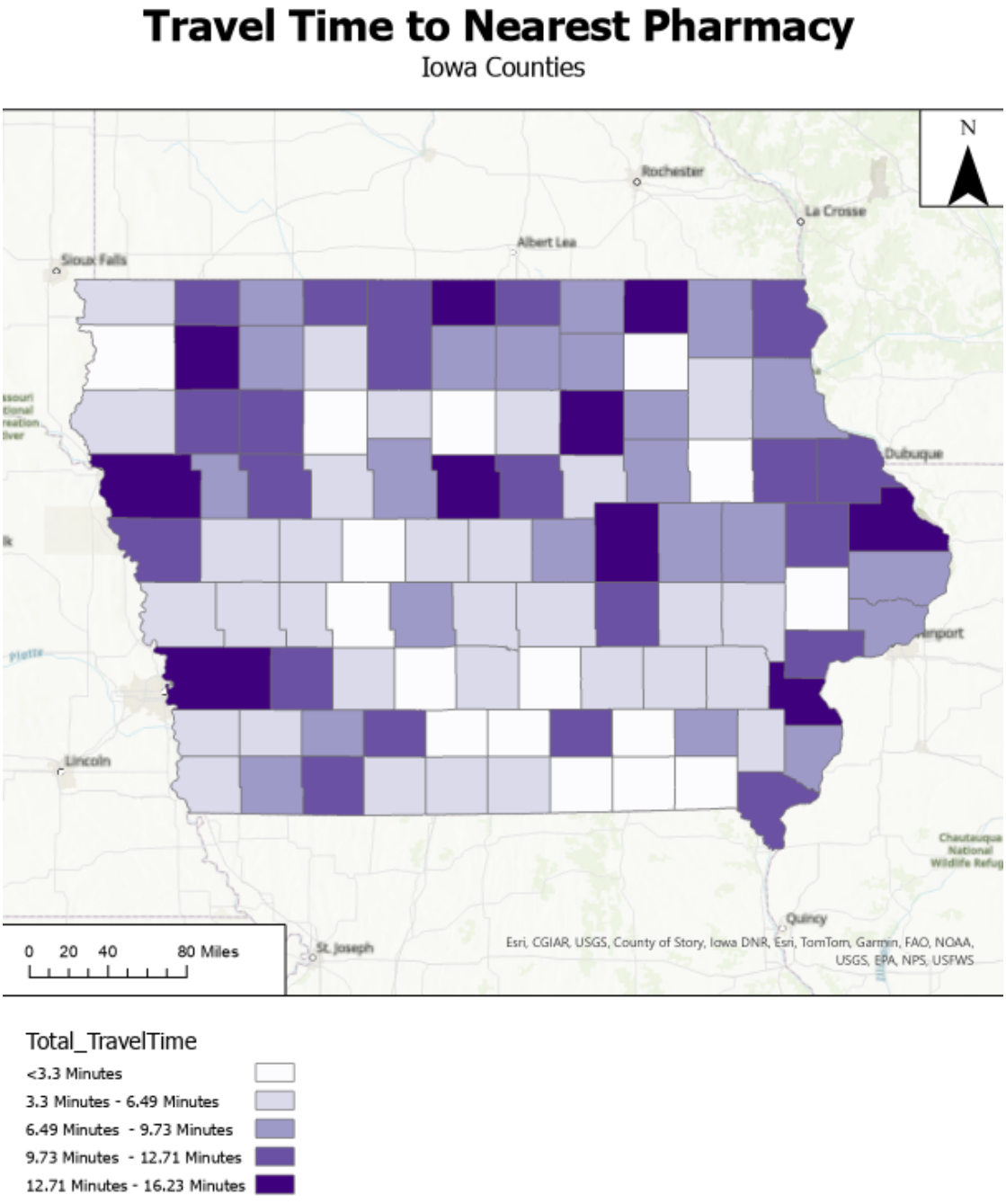
some lower-income counties still show a reasonable amount of these points. Which aligns with my Pearson correlation that indicates that there is a weak NEGATIVE relationship between pharmacies per ten thousand and income alone doesn't explain access.



Map 4:

Do lower-income counties have fewer pharmacies per ten thousand people, creating uneven access to essential medications?

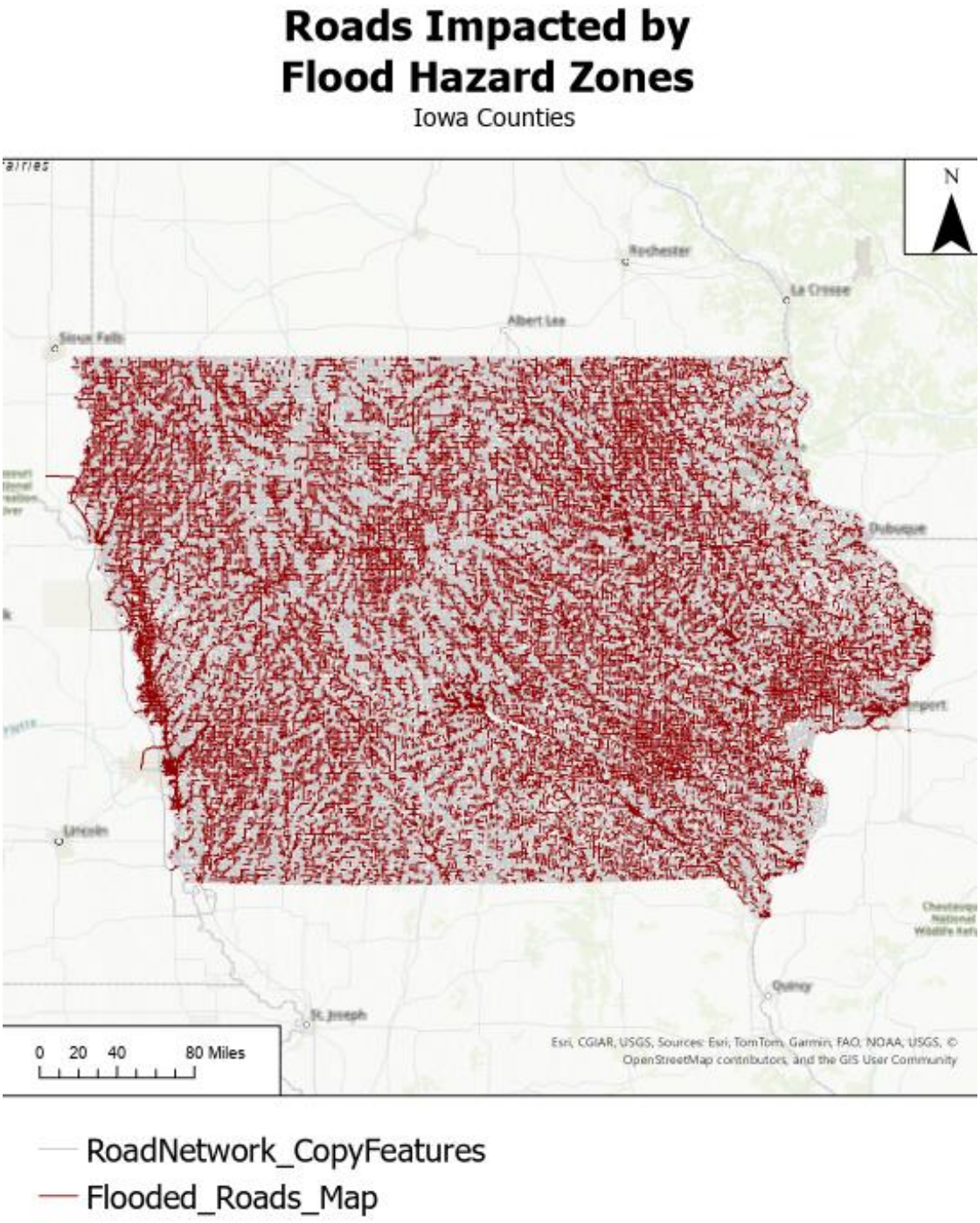
This map gives a view of median household income and pharmacy access per ten thousand people that is combined. It shows Iowa counties using a bivariate color scheme, pink tones show high income levels, blue tones show higher pharmacy access, darker purple areas show where both pharmacy availability and income is relatively high. On the other hand lighter shades show counties with lower income and fewer pharmacies per ten thousand people. It shows regions that may face challenges in healthcare access. This visualization was useful because it shows areas that have overlapping patterns which helps to show us areas that are needed for critical and targeted intervention for improving equity in healthcare delivery.



Map 5: Travel Time to the Nearest Pharmacy from County Centroid

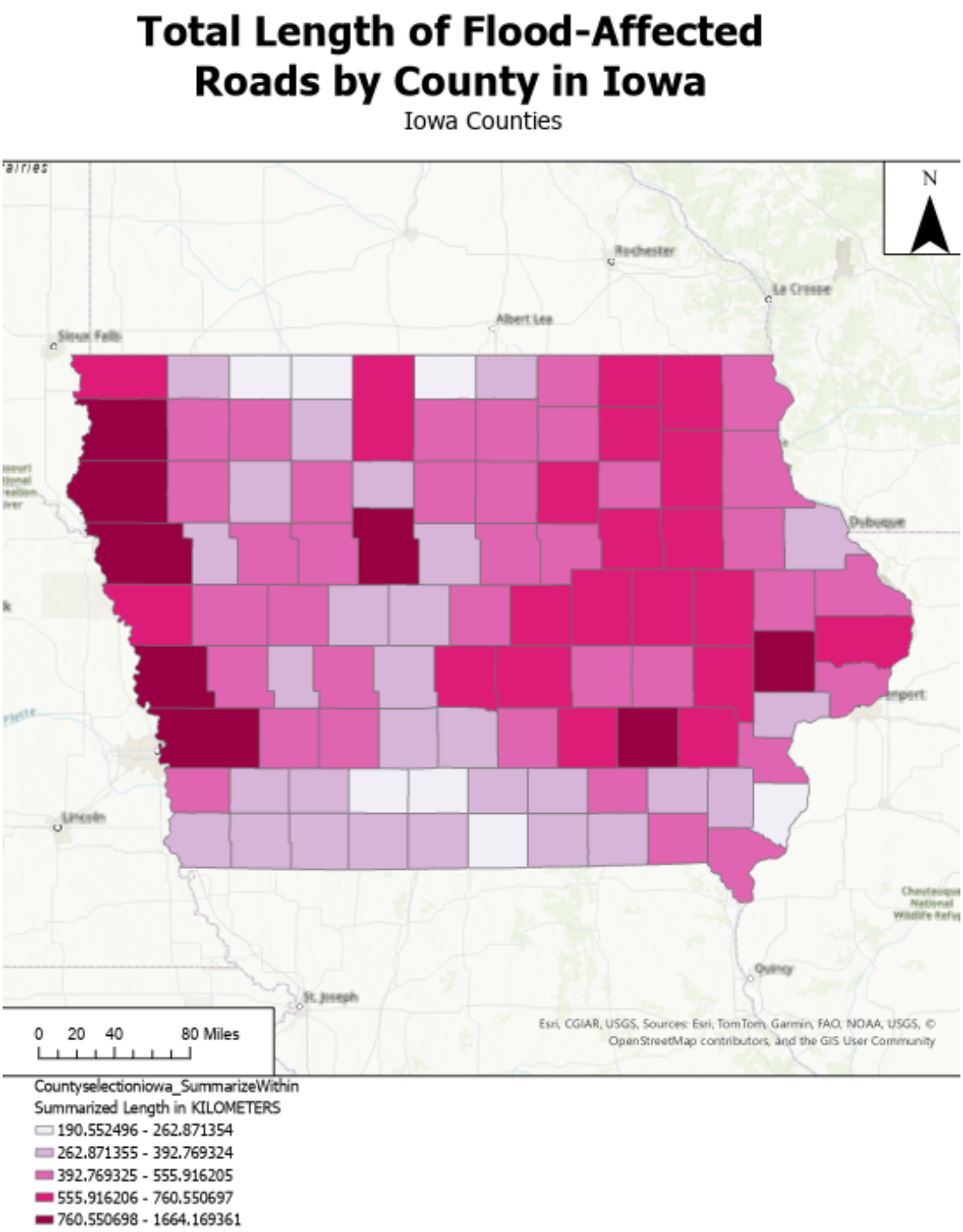
This map shows the average travel time per county centroid to the nearest pharmacy across Iowa Counties. It uses a gradient from light to dark purple where lighter shades are shorter travel times (under 3.3 minutes) and darker shades are longer times (up to 15.23 minutes). The pattern shows that rural counties, especially in western and southern Iowa, tend to have travel times that are

longer while urban areas are populated more densely and they have quicker access. This map shows where there a disparities to pharmacy accessibility and where residents that are rural may face barriers due to distance.



Map 6: Which Roads are Impacted By Flood Hazard Zones

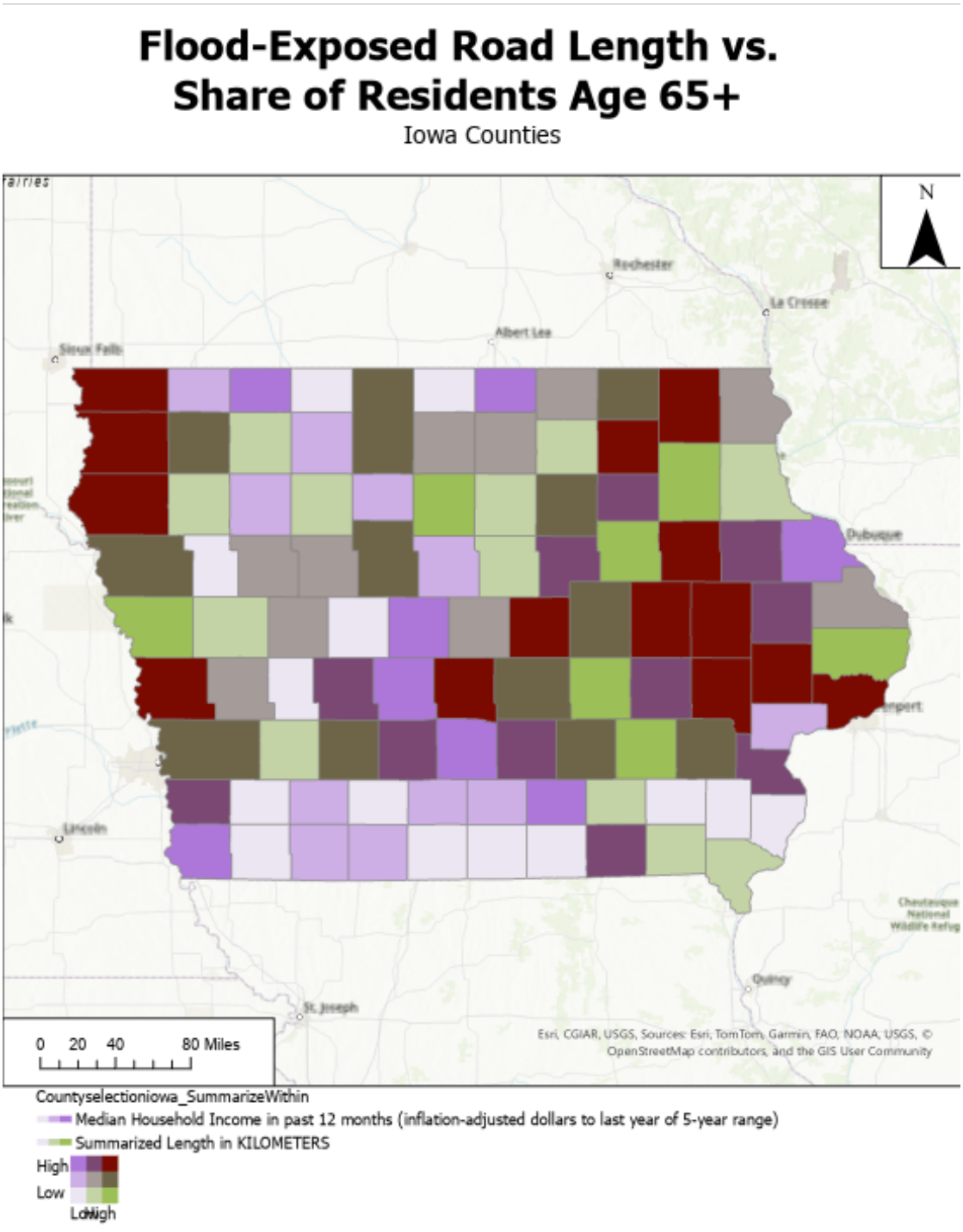
The map titled “Roads Impacted by Flood Hazard Zones” depicts Iowa’s entire road infrastructure. The image shows the roads that intersect with flood zones in red. The image shows how vulnerable the road network is across the whole state. There are dense clusters of roads in both urban and rural areas that are impacted. This is important for your analysis as these roads that are affected could exacerbately impair access to pharmacies especially in rural counties. This map furthers your report by demonstrating the extent to which flooding could disrupt access to pharmacies and completes your scenario modelling for pharmacy access during flood hazard events.



Map 7: Total Length of Flood-Affected Roads by County

For this map I used a graduated color scheme to show the total kilometer of roads within flood hazard zones for each county. The darker shades of magenta show counties with the highest cumulative road length exposure to flooding. The lighter shades indicate lower exposure. This map shows that some eastern and central counties have more roads that are affected by floods.

Which could lead to transportation disruptions during flood events, this is important because counties with road exposure that is extensive may have longer detours and delays in accessing pharmacies and healthcare services.



Map 8: Flood-Exposed Road Length vs. Share of Residents age 65+

This bivariate map combines two variables, the first one being flood-exposed road length and the second one being the percentage of residents that are aged sixty-five and older. The color blend of green, purple, and brown colors shows different combinations of low and high values for each variable.
Counties that are shaded in darker brown or mixed tones show areas that both had high flood exposure and high elderly populations. This shows regions that may face compounded vulnerability during flood-related road closures. This helps show areas that are priority areas for emergency planning, since older adults tend to have high healthcare needs and may be affected disproportionately by limited access to pharmacies.

Conclusion

When I started this project, I wanted to understand how access to pharmacies varied across Iowa when looking at it from different lenses, such as age, income, roads, flood hazards, and population density. Working at a scale that was county level, it showed patterns that statewide averages tend to overlook. Pharmacies were clustered in and around urban areas, while some rural counties showed thinner coverage and longer travel times. By cleaning and integrating data and standardizing certain metrics, it provided a foundation for comparing counties where equity gaps are likely to occur the most.

The results that were descriptive point to accessibility being uneven. These maps linked pharmacies to concentration of elderly individuals and overall population density showed that the availability generally follows people, but not always the people who are most at risk. The income to access relationship was weakly negative, which indicated that lower income counties sometime have slightly MORE pharmacies per ten thousand people. This likely shows a mix of small population effects and service clustering in certain regional hubs. The bivariate visualization of income to pharmacies per ten thousand people clarified that the most pressing concerns were localized. There was a subset of counties that combined lower income with lower per ten thousand availability, which flagged places where affordability and physical access were jointly constrain timely medication access.

The modeled travel time to the nearest pharmacy was shortest in urban counties and longest across portions of western and southern Iowa. This underscores the distance of barriers faced by rural residents. Flood exposure analysis added a critical dimesions of about 50,385 of 357,287 road segments, which was about 14 percent that intersected flood hazard zones, with

some counties showing hundreds of kilometers of flood-exposure roads. When closures coincide with alternative routes that are limited, the routine trips can become detours or delays. Disproportionately, this affects older adults and residents in low-access counties. The bivariate map of flood-exposed road length and the percent of people who are 65+ highlights priority counties where infrastructure risks and the elderly population overlap.

These findings show areas where local leaders and city planners could potentially try to add more pharmacies. At a county level, there should be new pharmacies in low-access, high need areas, mobile pharmacy services, and medication delivery programs could help bridge gaps where this isn't possible. Also being aware of routing, which includes alternative routes that are pre-identified. When combining these strategies, it could improve accessibility where it is most needed.

There are a few limitations and things I would like to investigate more in the future. This study relies on county-level aggregation, which could mask disparities within the county. The correlation results don’t establish causation and were not accompanied by full inferential testing. Travel time estimates were based on centroid-to-nearest routing and may understate real-world variability. In future work, I would incorporate tract-level analysis and network-based service areas.

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