

Report: Watersheds surrounding the Ogallala Aquifer

by Gwen for
UCLA's GIS181B

Introduction

The goal of this project was primarily to supplement an upcoming project pertaining to the Ogallala Aquifer. That project aims to analyze the water resources available within the Ogallala aquifer by providing an overview of the areas' watershed networks, water quality, and overall depletion of the Ogallala compared to historical levels. By analyzing these metrics, it will become clear if any strong correlations exist between water quality and depletion, as well as both metrics with geographic distribution of water in the watershed. This project aims to contribute to this overarching goal by analyzing the surface watershed network in the Ogallala region, and drawing connections between these surface water networks and the underground water in the Ogallala Aquifer.

Methods

Watershed analysis was conducted using a [GMTED2010 500m / 15 arc-second DEM](#) of the central and western United States. The raster was initially filled to remove imperfections, then used to derive a flow direction raster representing the direction water will flow under the assumption that it always flows downwards due to gravity. Using this flow direction raster, a flow accumulation raster was generated, representing the locations in which amounts of water will accumulate and thus where streams will form. To represent real life rivers more accurately, Google Earth and HydroSHEDS data was examined and used to determine a threshold value. This value was used to create a new accumulation raster, which was used to create a stream raster containing stream order information. Finally, this order raster was converted to a vector shapefile and used in Map 1. In addition to this, the flow direction raster was also used to derive a raster containing basin boundaries, which was similarly converted to polygon features and used for analysis. These derived basins were then supplemented with [HUC8 watershed boundary data](#) to check accuracy and create a detailed basin map (Map 2). Both Map 1 and Map 2 include [the boundary of the Ogallala Aquifer](#). The final section of geoprocessing also utilized the flow accumulation raster. In ArcGIS, the zonal statistics tool was used alongside the a US County boundary dataset in order to yield a raster containing information about which counties have the highest average flow accumulation. This floating point raster was then converted to an integer raster, and then to a polygon shapefile which was used in Map 3.

Analysis

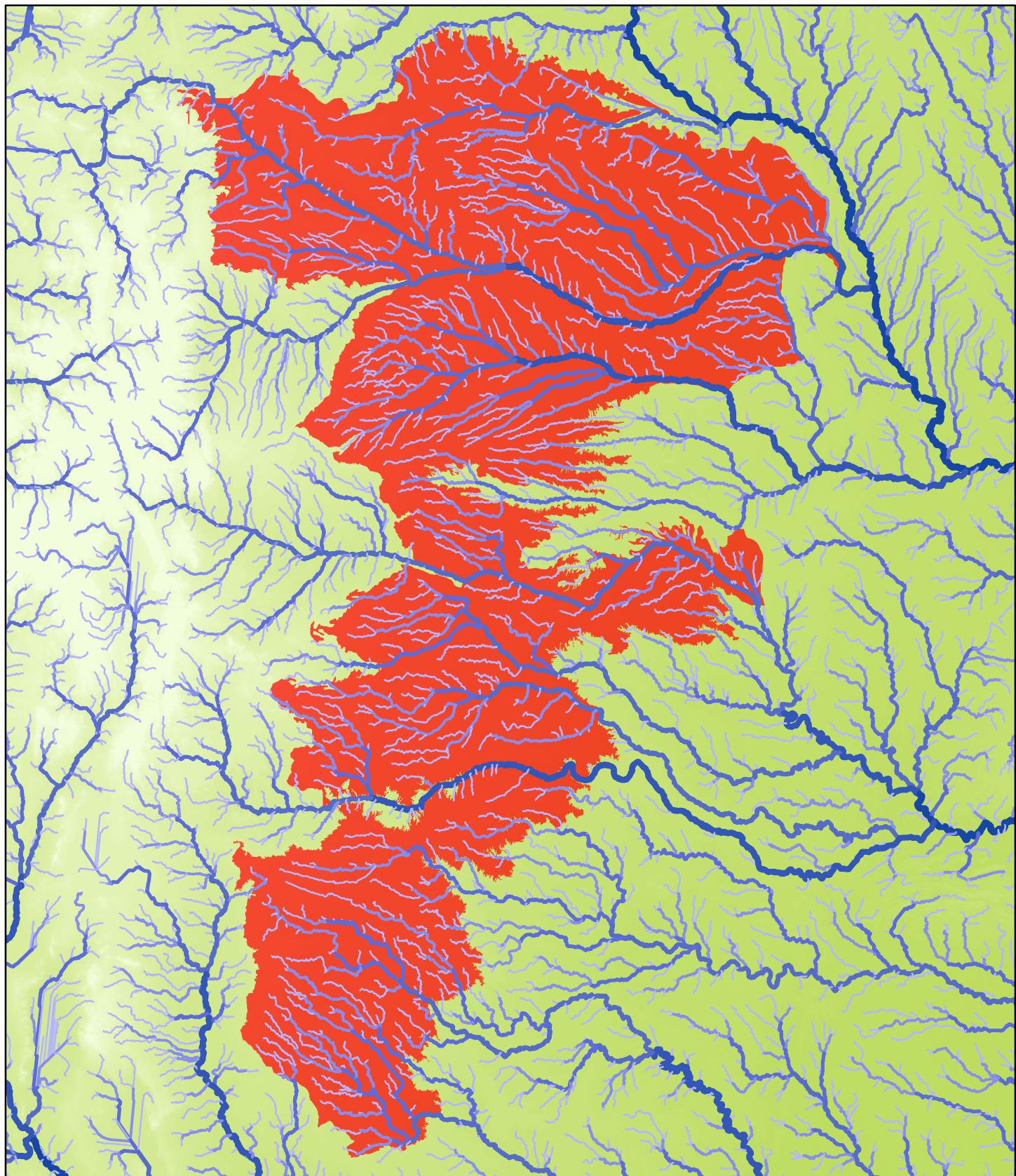
This researcher postulates that high average flow accumulation correlates with available water resources in the region, meaning Map 3 is indicative of available surface water resources in a given county. However, aquifers such as the Ogallala lie below the water table and provide additional water resources, meaning the flow accumulation raster does not correlate with aquifer depth. Instead, a more interesting comparison to make would be to aquifer recharge rate, as well as recent aquifer change in depth; this will be explored further in the upcoming project. In addition to the by-county information provided in Map 3, Map 2 provides qualitative information about the locations of basins. In many places, the HUC-8 basin boundaries align closely with the boundaries of the Ogallala; particularly in the northeastern section. In addition to boundaries, the relative width and height of these water features also correlates in many places. This could be due to geologic formations shaping the way water collects.

Appendix

This appendix contains the following maps in order:

- ❖ **Map 1:** River Network of Ogallala Aquifer and Surrounding Areas
- ❖ **Map 2:** Basins of Ogallala Aquifer and Surrounding Areas
- ❖ **Map 3:** Ogallala Aquifer Region, Average Flow Accumulation by County

Map 1: River Network of Ogallala Aquifer and Surrounding Areas



Ogallala Aquifer **Streams by Order**

First Order

Second Order

Third Order

Fourth Order

Fifth Order

Sixth Order

Sixth Order

Seventh Order



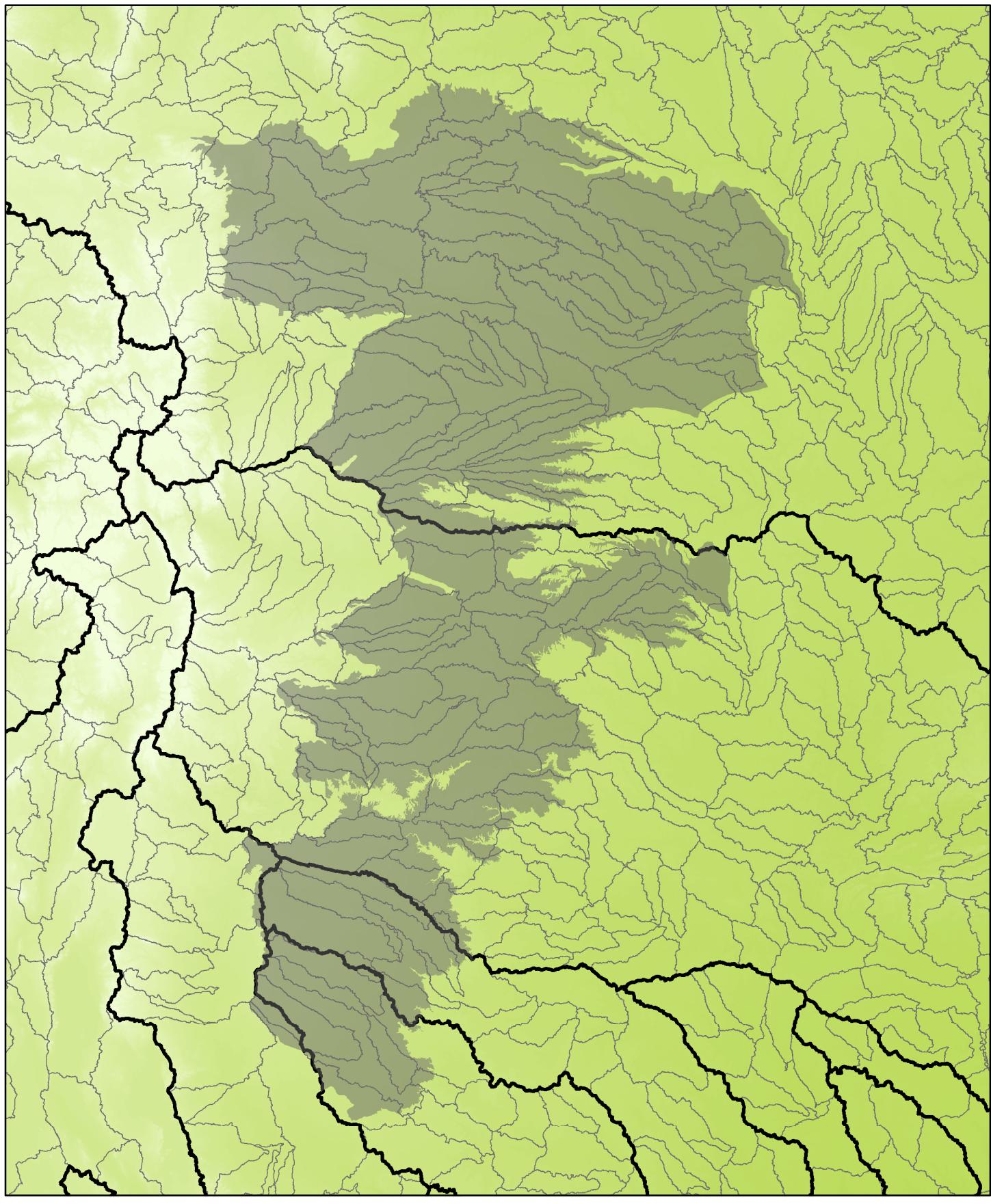
0 25 50 100 150 200

Miles

Scale 1:6,230,000

Map created by Gwen. <https://github.com/gowin20>

Map 2: Basins of Ogallala Aquifer and Surrounding Areas



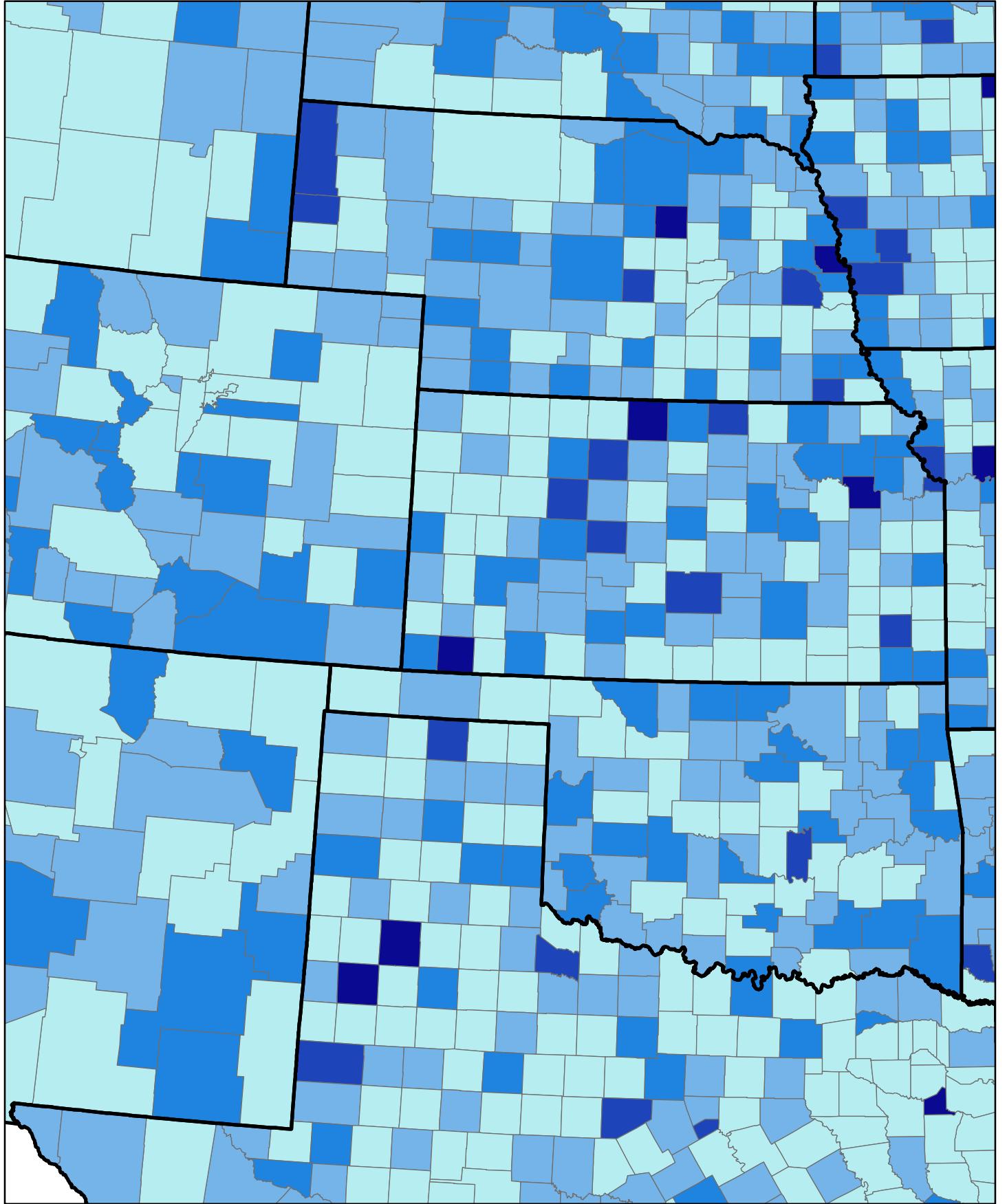
0 25 50 100 150 200 Miles

Scale 1:6,600,000

Map created by Gwen.
<https://github.com/gowin20>

- Ogallala Aquifer
- Derived Basins
- HUC8 Basins

Map 3: Ogallala Aquifer Region, Average Flow Accumulation by County



N

0 25 50 100 150 200 Miles

Scale 1:6,230,000

Map created by Gwen.
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Average flow by county

90,400 - 18,500,000

18,500,000 - 36,500,000

36,500,000 - 70,600,000

70,000,000 - 139,000,000

139,000,000 - 629,000,000

Standard Reference

[GMTED2010 500m / 15 arc-second DEM](#)

[HUC8 watershed boundary data](#)

[Boundary of the Ogallala Aquifer](#)