Kansas High Plains Aquifer

Kansas Water Hub

University of Kansas

June 24th, 2024

Motivation for Project

Conserve and Extend the High Plains Aquifer

Data, Research, and Study Needs

Continue evaluation of emerging innovations in collaboration with KSU and other partners.	Expand research on drought-tolerant crops to determine suitability for identified areas.	Expand research on optimum plant development stages to determine efficient irrigation water application.
Provide the public with reports that include studies and real world outcomes demonstrating the benefits of pumping significantly less water.	Expand research on the effects of playa lakes on aquifer recharge and the effects of agriculture crop production on playa lakes' ability to provide recharge.	Evaluate and identify ways to create new and strengthen existing markets for less water-intensive crops.
Implement research-based technology aimed at better understanding our state's water supply	Evaluate, identify, and encourage efficient system technologies for use by Kansas irrigators and other water users.	Expand research on efficacy of water reuse programs.

Table: Kansas Water Plan Highlighted Needs

Questions of Interest

How has well water use changed over time in the five Groundwater Management Districts?

We want to find ways to visualize these changes in ways that best address the sustainability of use and the effectiveness of efforts underway.

How has well water use changed over time in the watersheds in Kansas?

We want to find ways to visualize water use at the watershed level so that use can be connected with other factors best measured at the watershed level.

Processing data related to the first pillar of the Kansas Water Plan

1. WIMAS
   - The Kansas Department of Agriculture, Division of Water Resources (DWR) and Kansas Geological Survey (KGS)
   - Link to WIMAS

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2. WIZARD
   - Most of the data stored has been taken from the U.S. Geological Survey's GWSI (Ground Water Site Inventory) and with the exception of those wells included in the Kansas monitoring well network, none of this information has been verified.
   - About two-thirds of the annual water-level data are now submitted by local GMDs and the Division of Water Resources, with the other third being updated by the KGS.
   - WIZARD is owned and operated by the Kansas Geological Survey.
   - Link to WIZARD

WIMAS Data

From the Kansas Water Plan: "*Kansas has more than 35,000 wells with active water rights; over 27,000 of these wells overlie the HPA, with approximately 87% of them used for irrigation.*"

WIMAS Data Used for the Kansas Water Dashboard

- We obtained WIMAS data directly from the Kansas Geological Survey (Brownie Wilson sent Thomas Becker a GIS file)
- This file has information about water use in acre-feet
- It is identified with a point of diversion ID
- There are 51,051 unique point of diversion IDs

Data Structure

WIMAS Data Structure

Data is structured at the well location (point of diversion) - year level.

Data Wrangling: Part 1

The data shared by KGS comes in GIS format. We conduct spatial joins in Arc Pro to add county identifies to each point of diversion location and watershed identifiers to each point of diversion location.

Data Wrangling: Part 2

We extract the underlying table to use in Statistical software packages R and Stata.

Descriptive Analysis

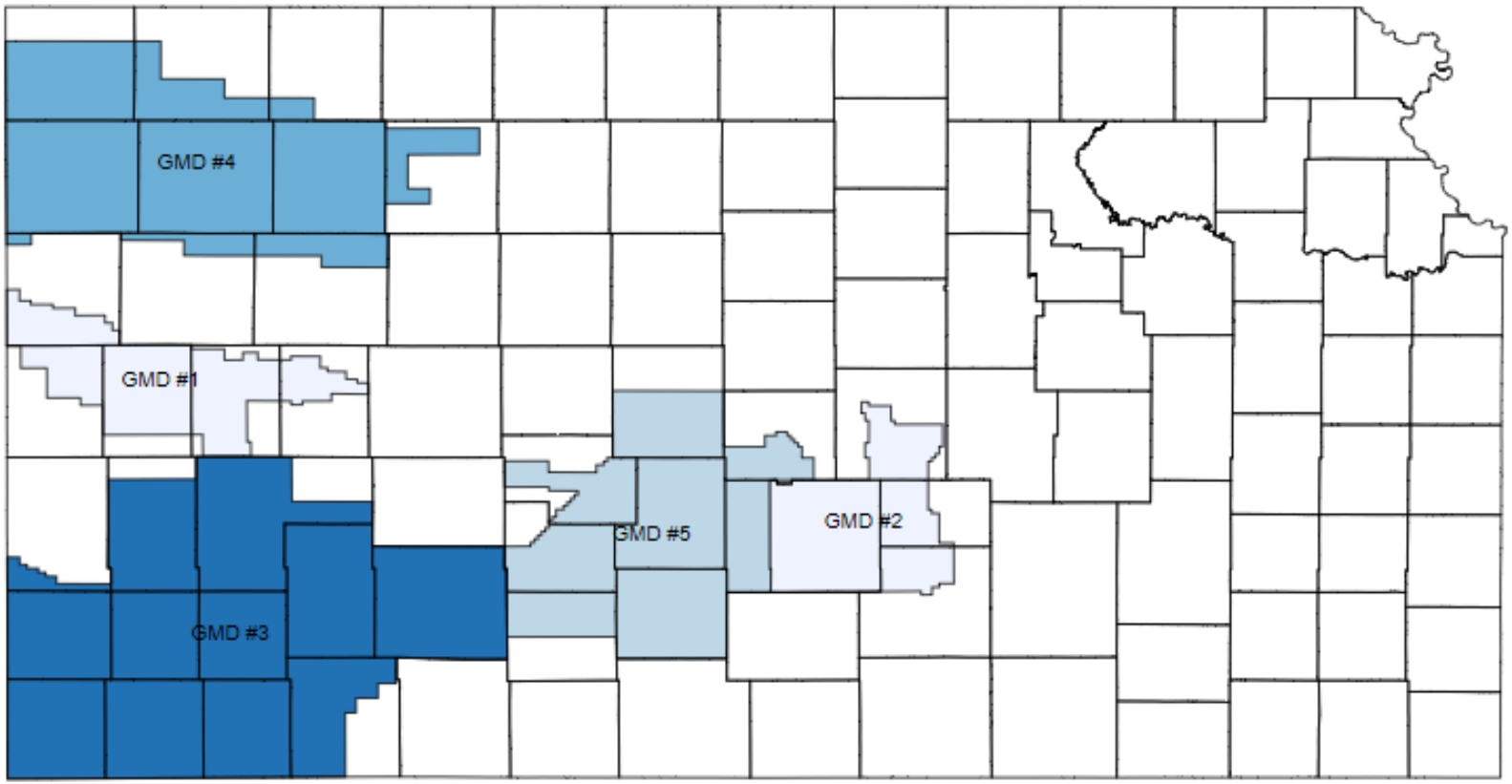
Trends in aquifer levels over time

These are well-established and publicized:

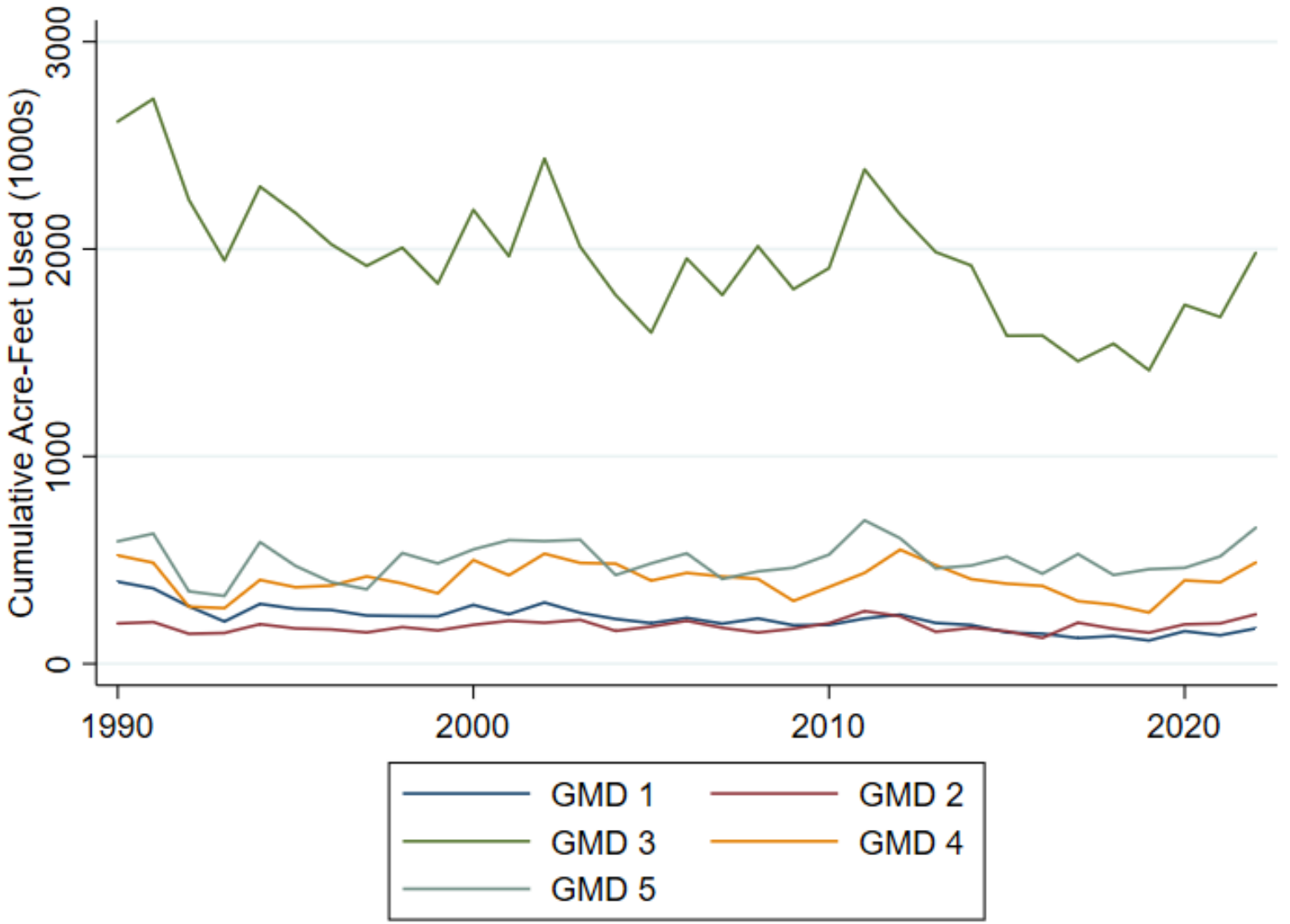
From the Kansas Water Plan: *"During the period of 1996 to 2016, the trends in the average annual water-level decline and the cumulative water-level declines for the three GMDs in the Ogallala region have been the following*

- GMD4. Steady decline rate: average 0.60 feet/year, cumulative 12.6 feet.
- GMD1. Steady decline rate: average 0.50 feet/year, cumulative 10.4 feet.
- GMD3. Increasing decline rate: average 1.69 feet/year, cumulative 35.4 feet.

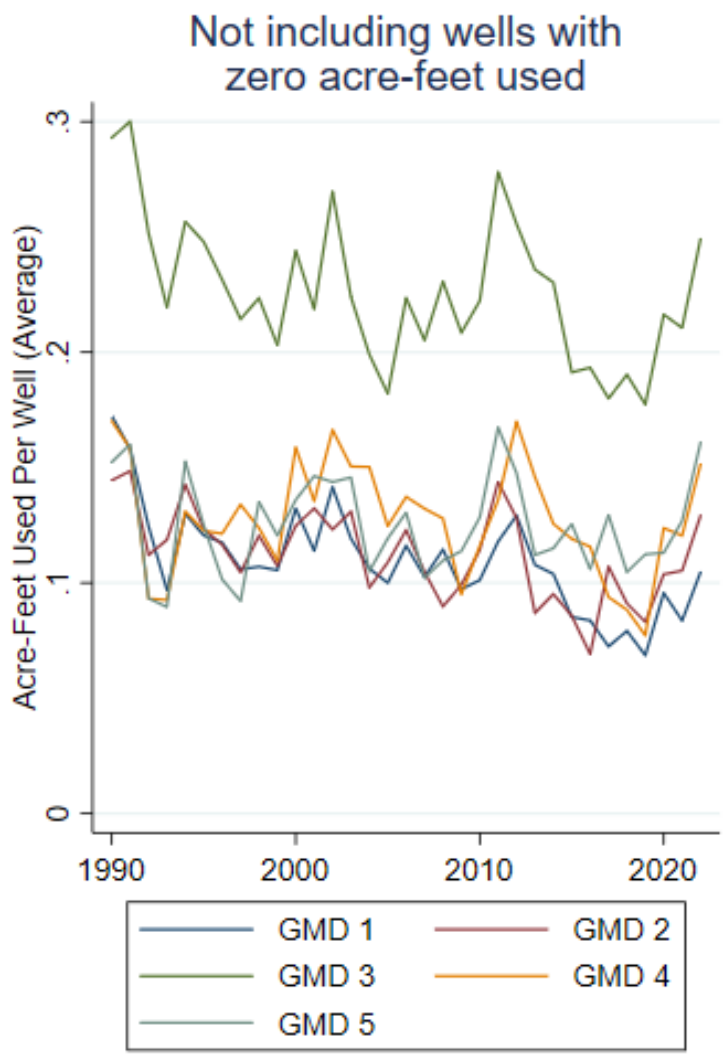
Groundwater Management District Analysis

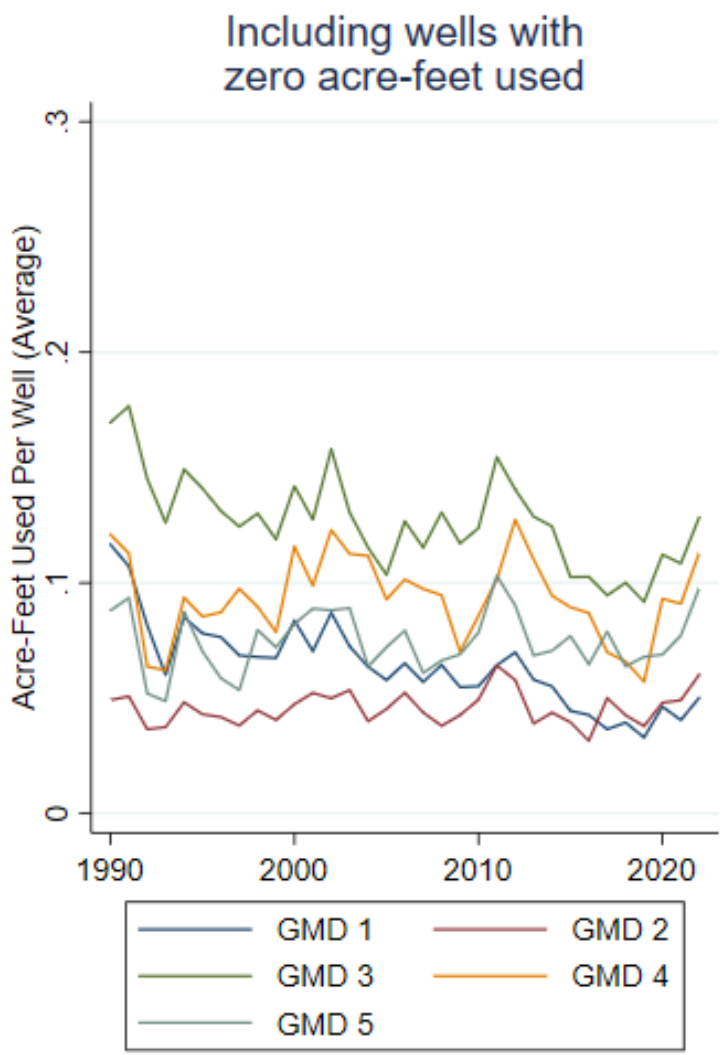


Aggregate water use by Groundwater Management District

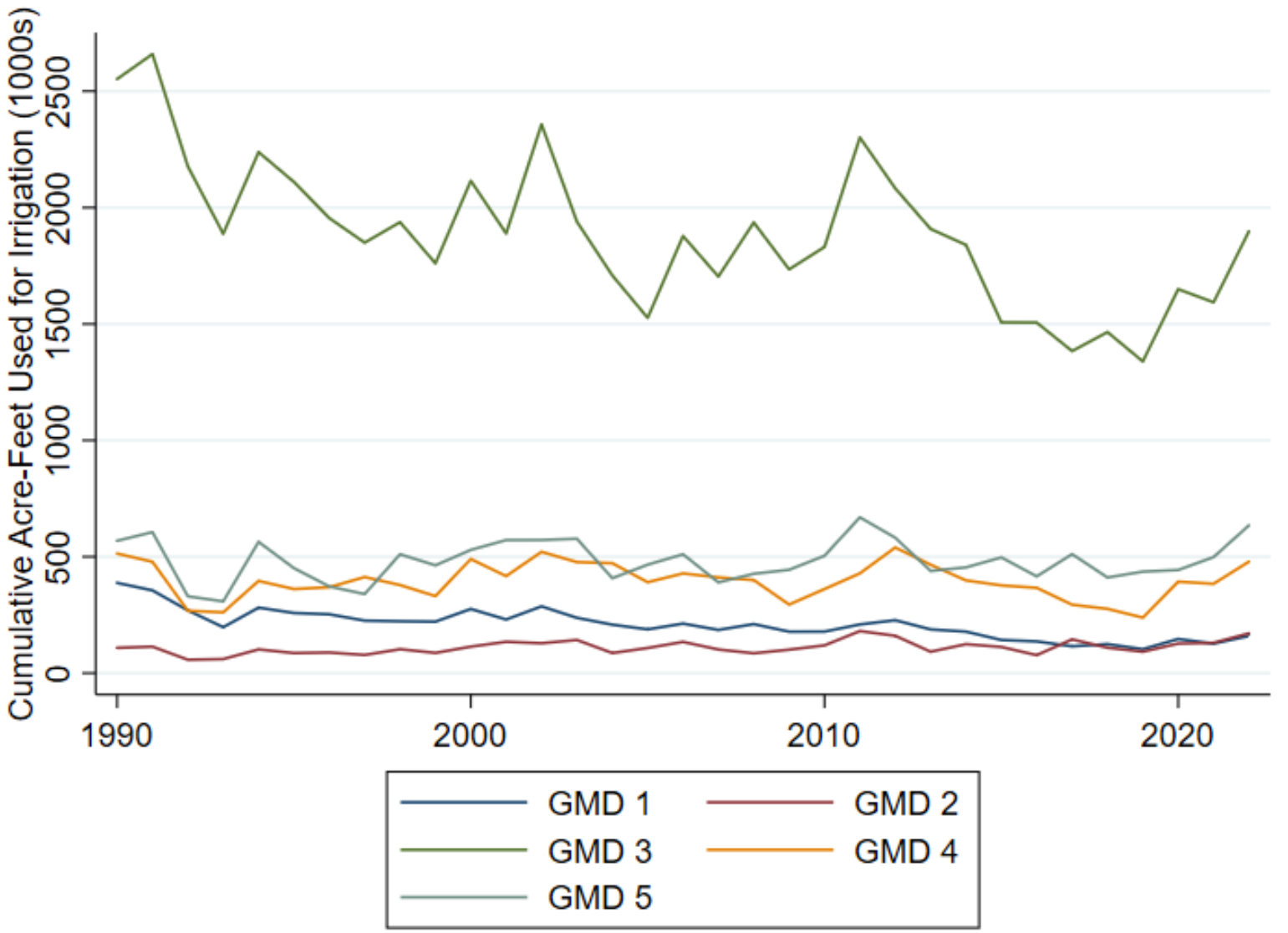


Average water use by Groundwater Management District Per Well

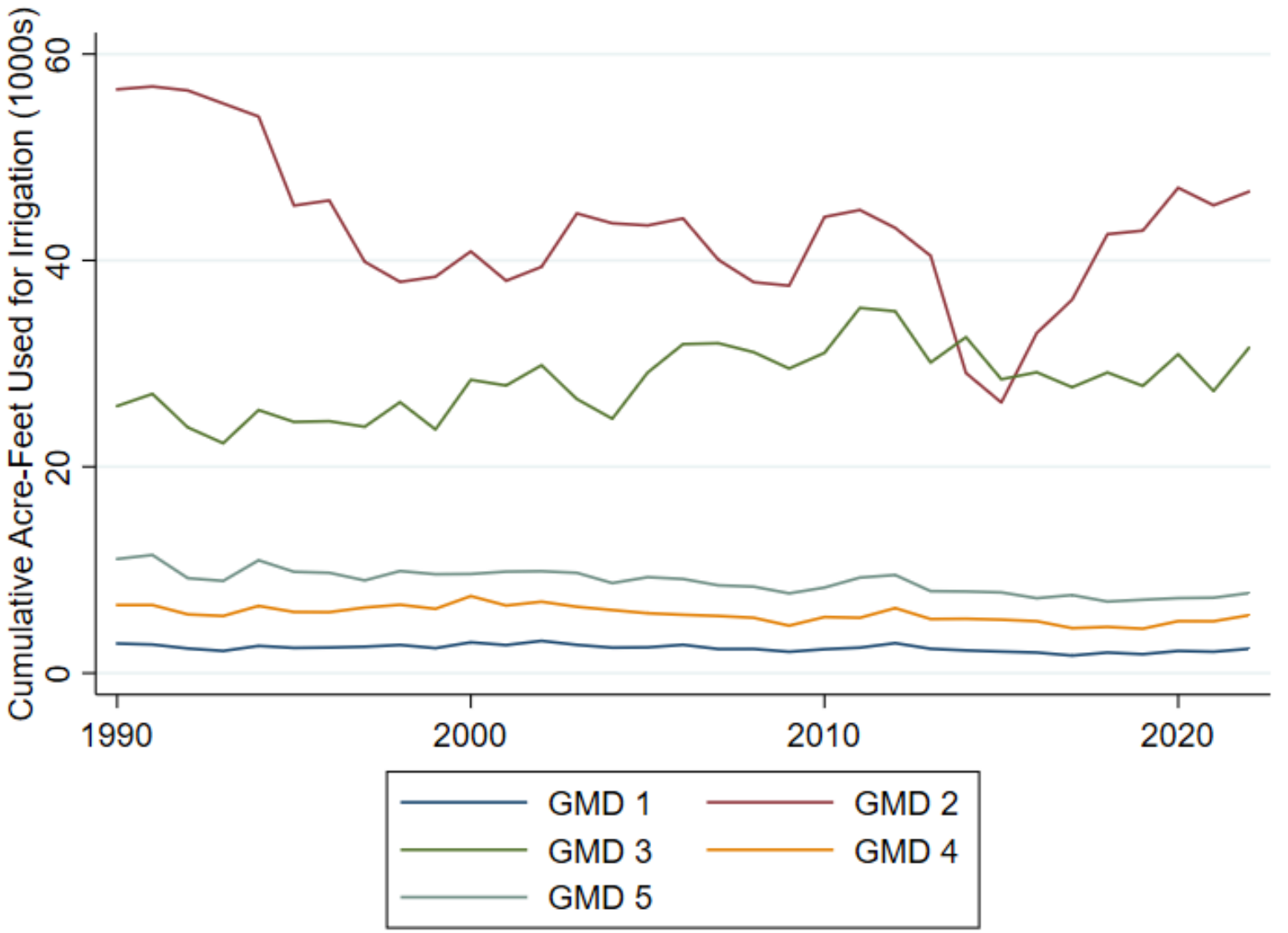




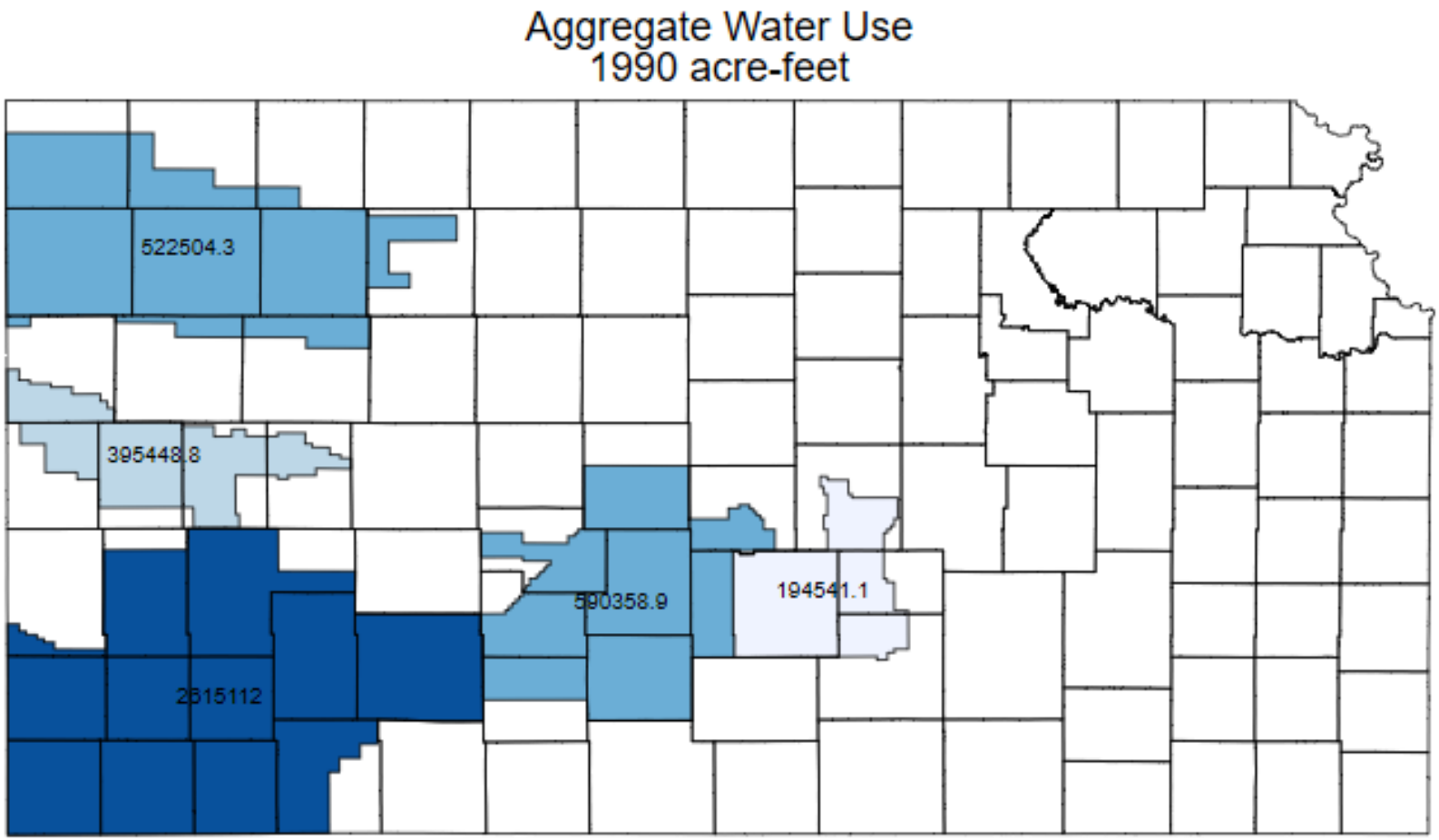
Aggregate water use for irrigation by Groundwater Management District



Aggregate municipal water use by Groundwater Management District



Aggregate water use: GMD Maps



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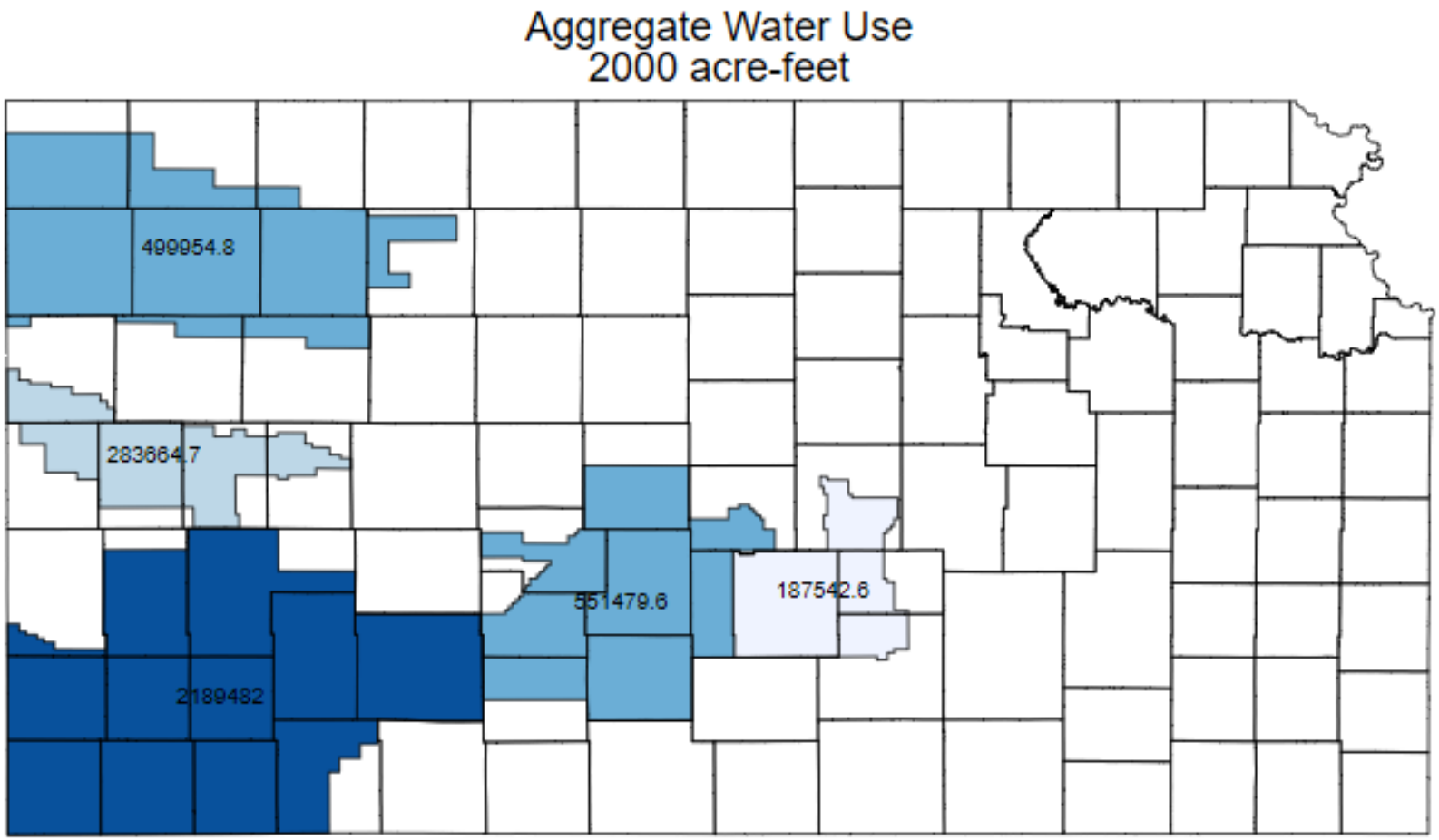

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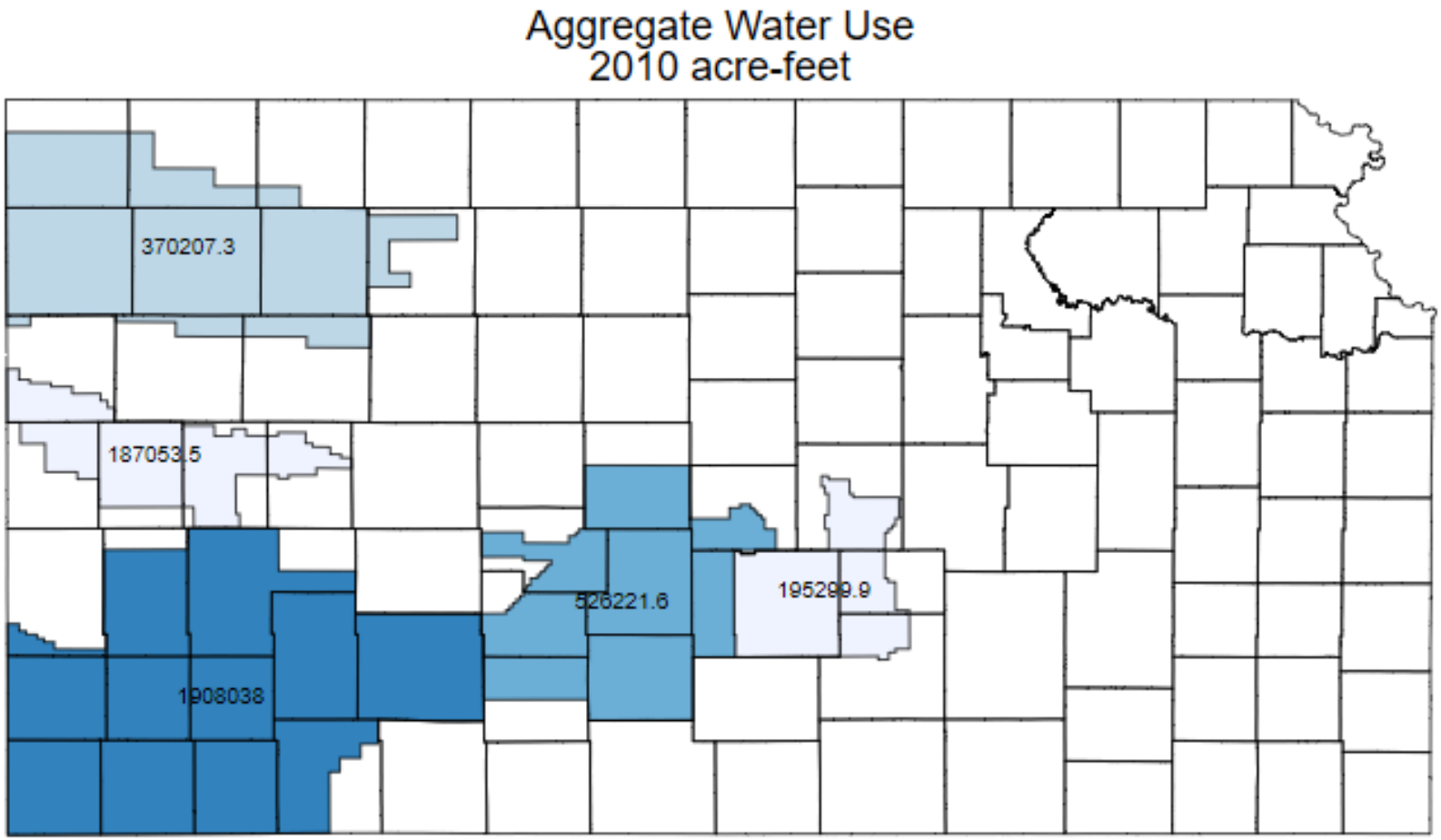
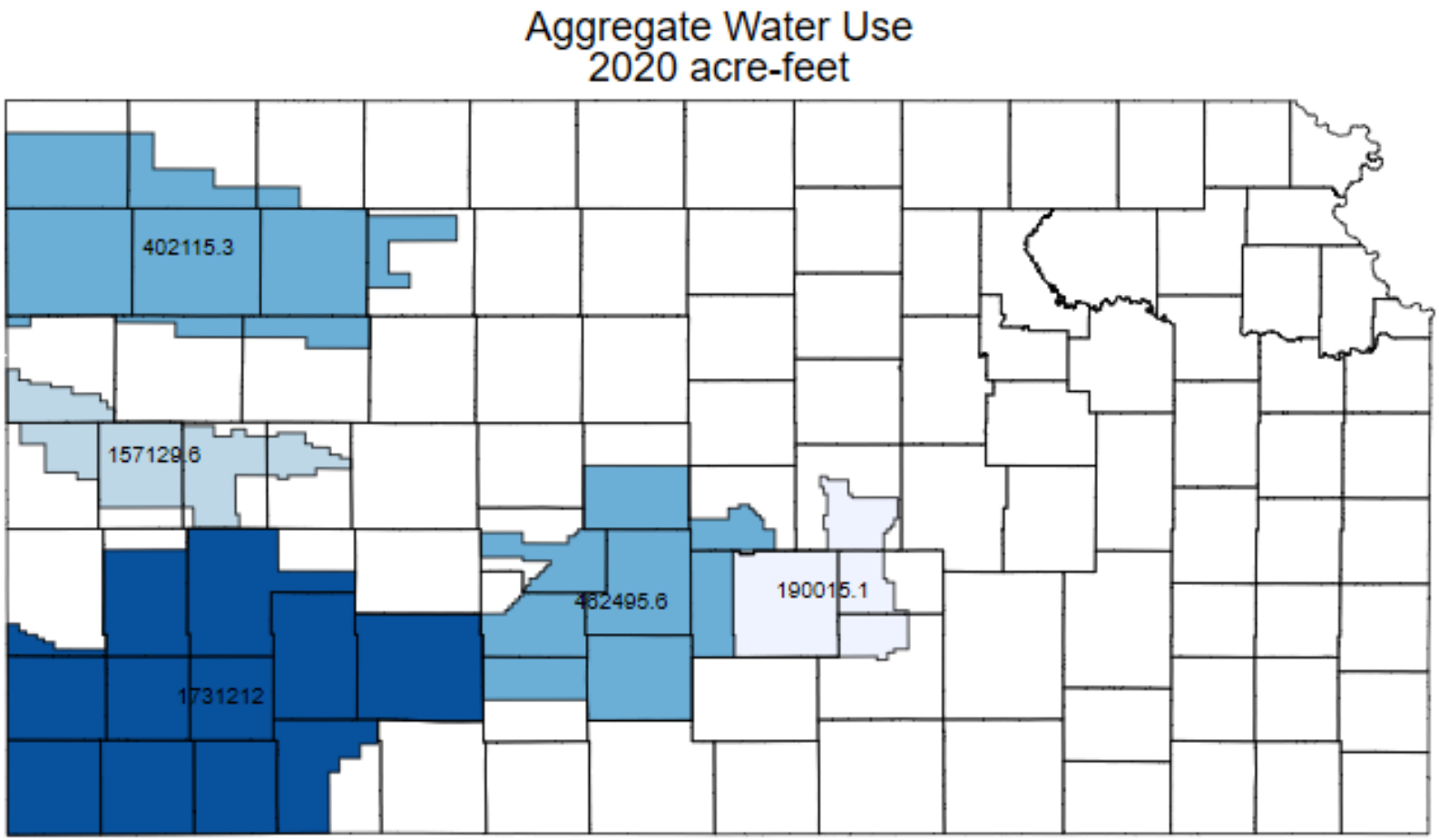
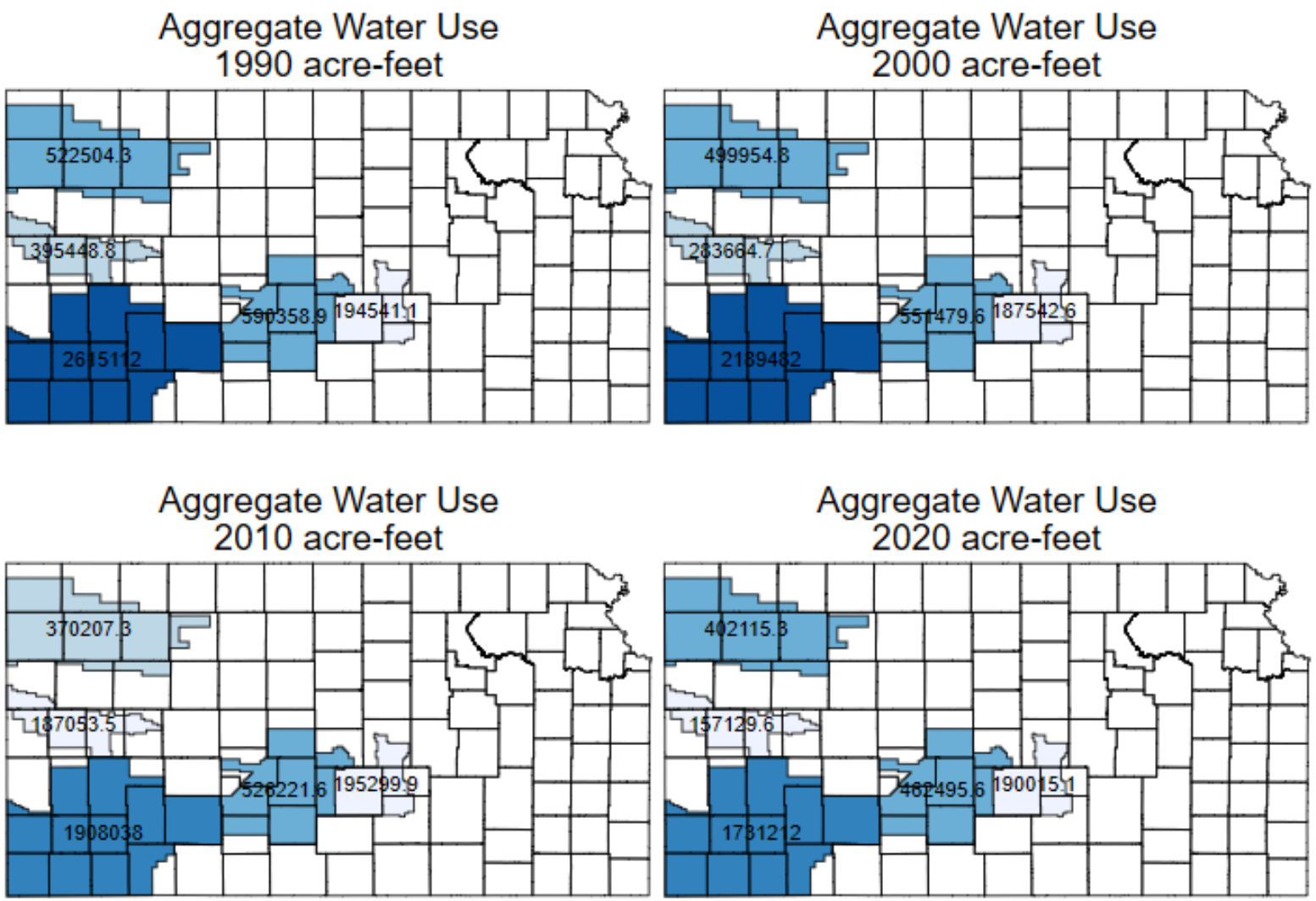


Aggregate water use: GMD Maps



Aggregate water use: GMD Combined Maps



Aggregate water use: GMD accompanying table

GMD	1990 Water Use	2000 Water Use	2010 Water Use	2020 Water Use
1	395,449	283,665	187,054	157,130
2	194,541	187,543	195,300	190,015
3	2,615,111	2,189,482	1,908,038	1,731,212
4	522,504	499,955	370,207	402,115
5	590,359	551,480	526,222	462,496

Note: these aggregates are calculated by adding reported use by water rights within GMDs. Aggregate use is reported in acre-feet.

Considerations to add to these figures

Level of water rights granted

Find a good way to show the level of water rights granted vs the level of water rights used.

Lever of water use that is sustainable

Include information about the level of sustainable water use the aquifer could maintain and visualize that with actual water use.

Other

If you can think of other good context for water use, please include that in your survey feedback responses.

Level of Water Use by Watershed Over Time

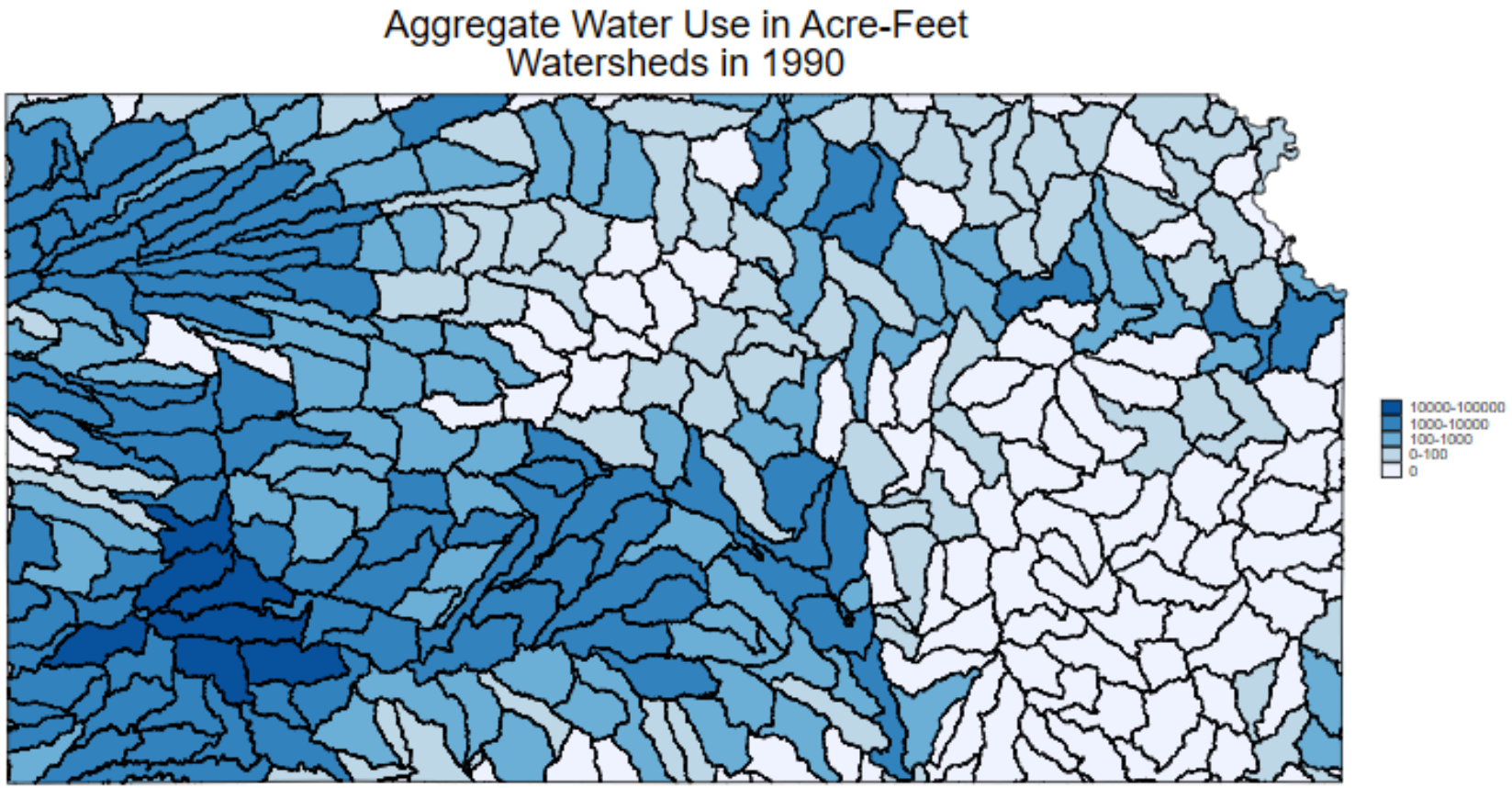
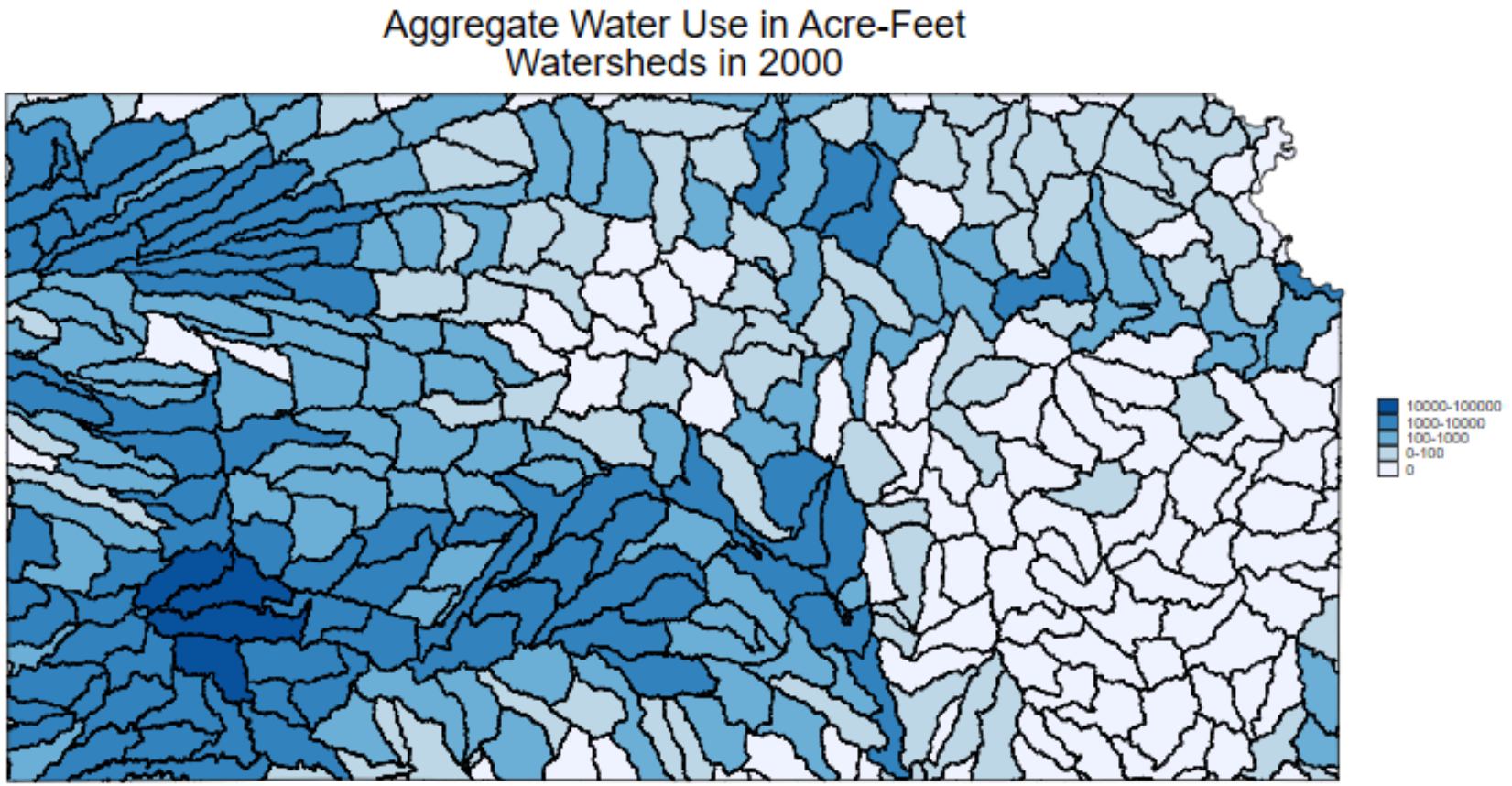


Figure: The highest level of water use is concentrated in the dark blue watersheds in Southwest KS.

Level of Water Use by Watershed Over Time



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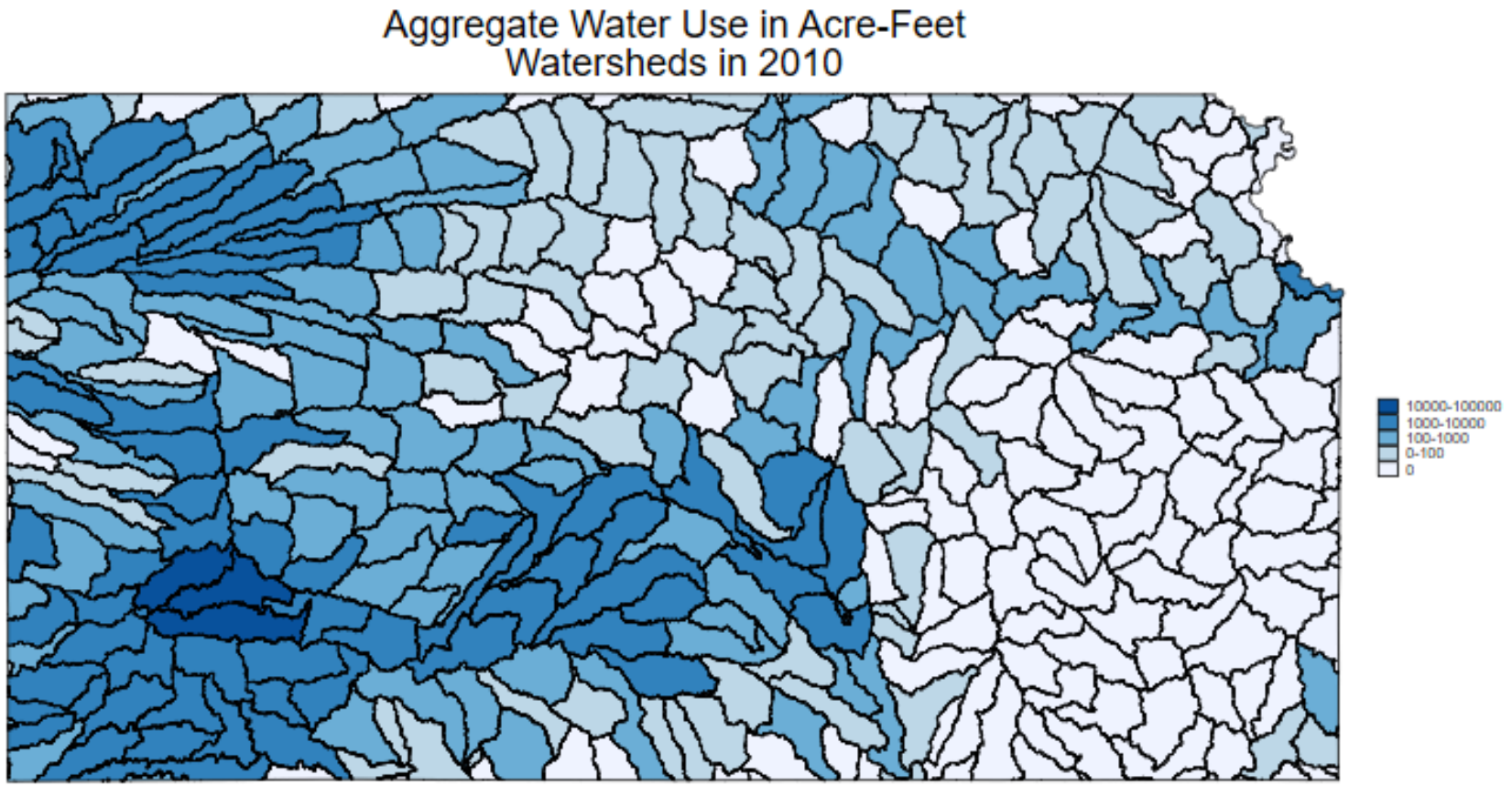


Level of Water Use by Watershed Over Time

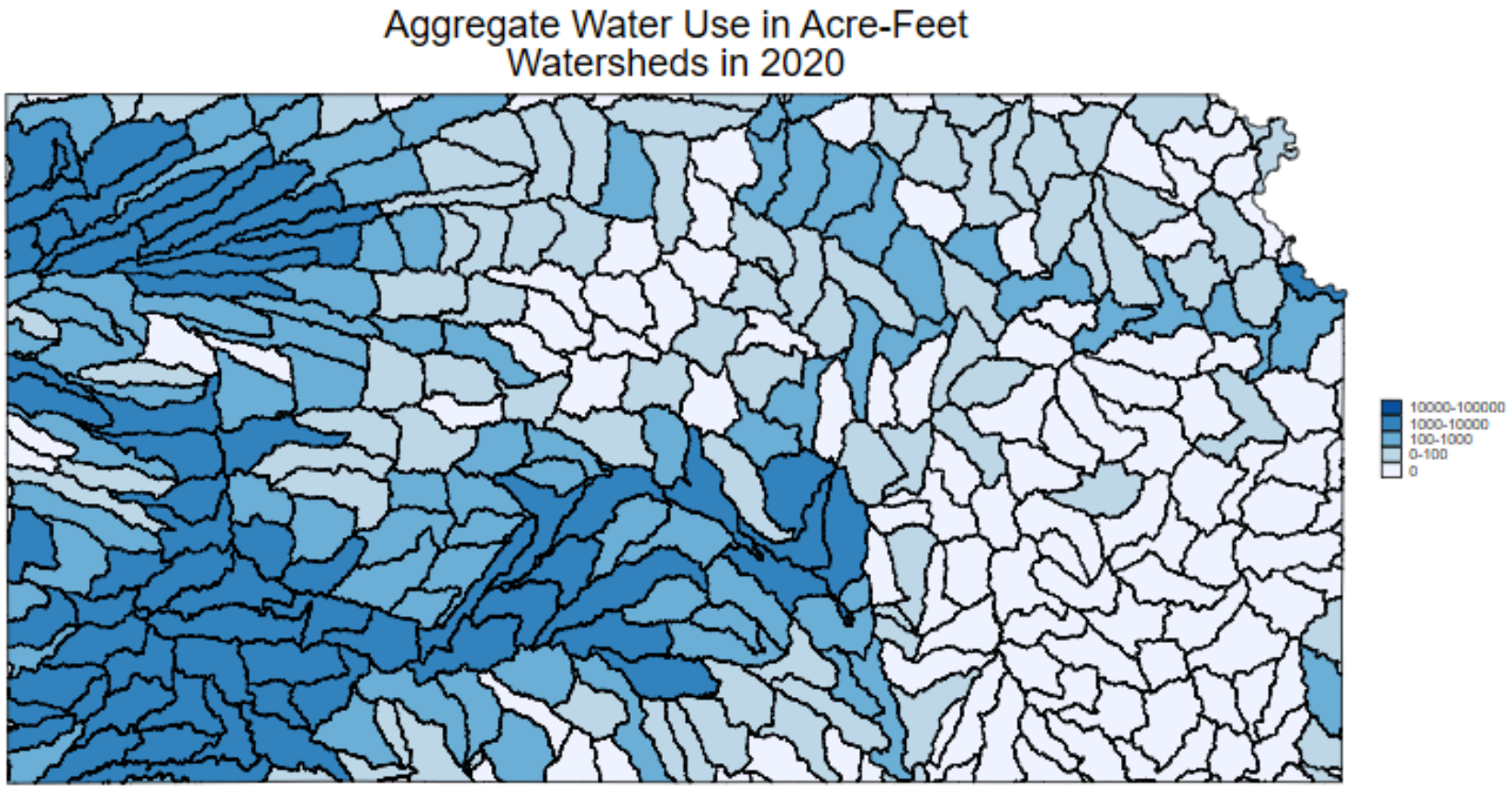


Figure: By 2020, no watershed is in the highest range of use that was seen in 1990.

Percent change in water use by watershed: 1990 - 2000

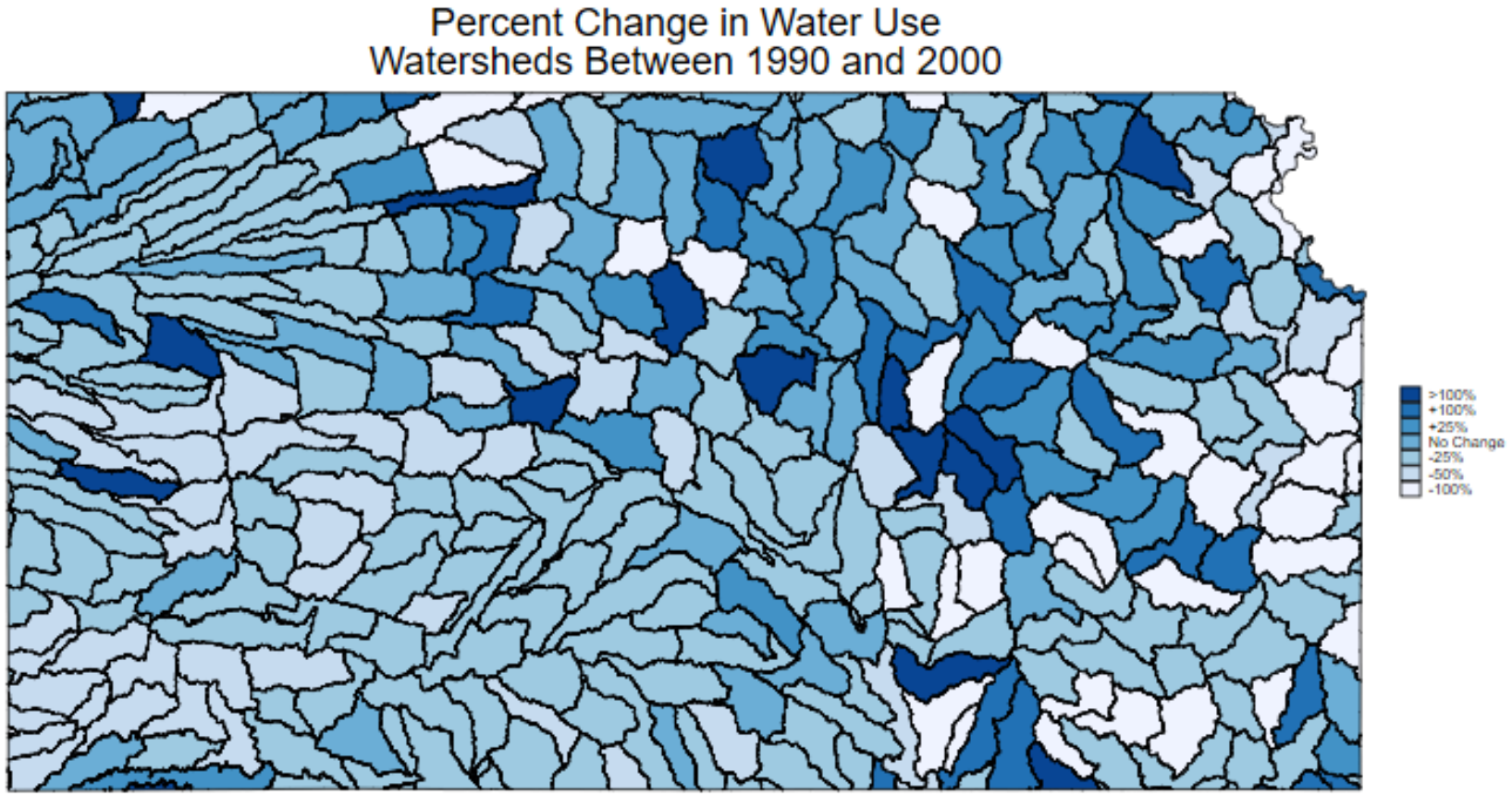
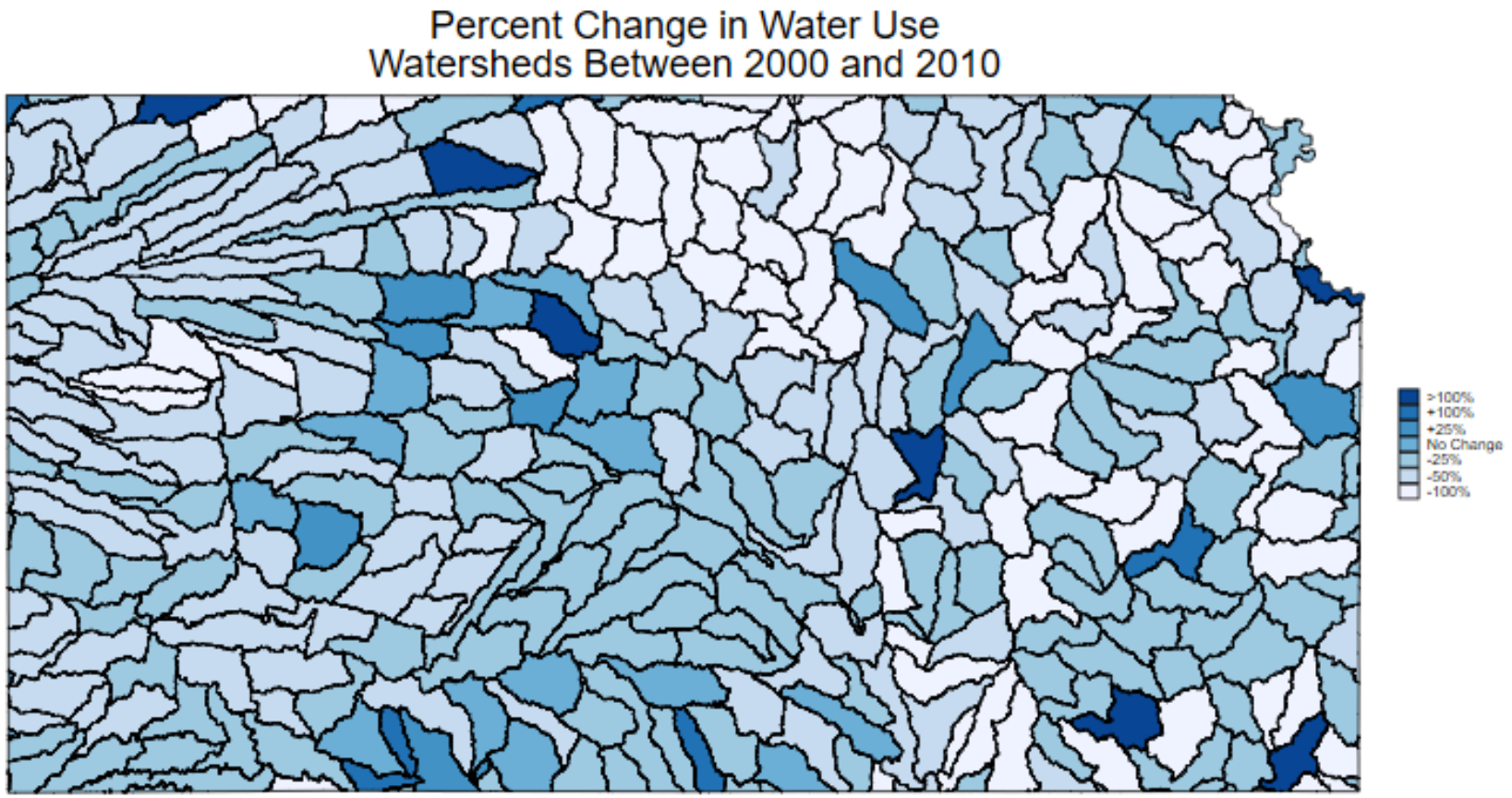


Figure: We can caption some of that decline visually by looking at the percent change between the decades.

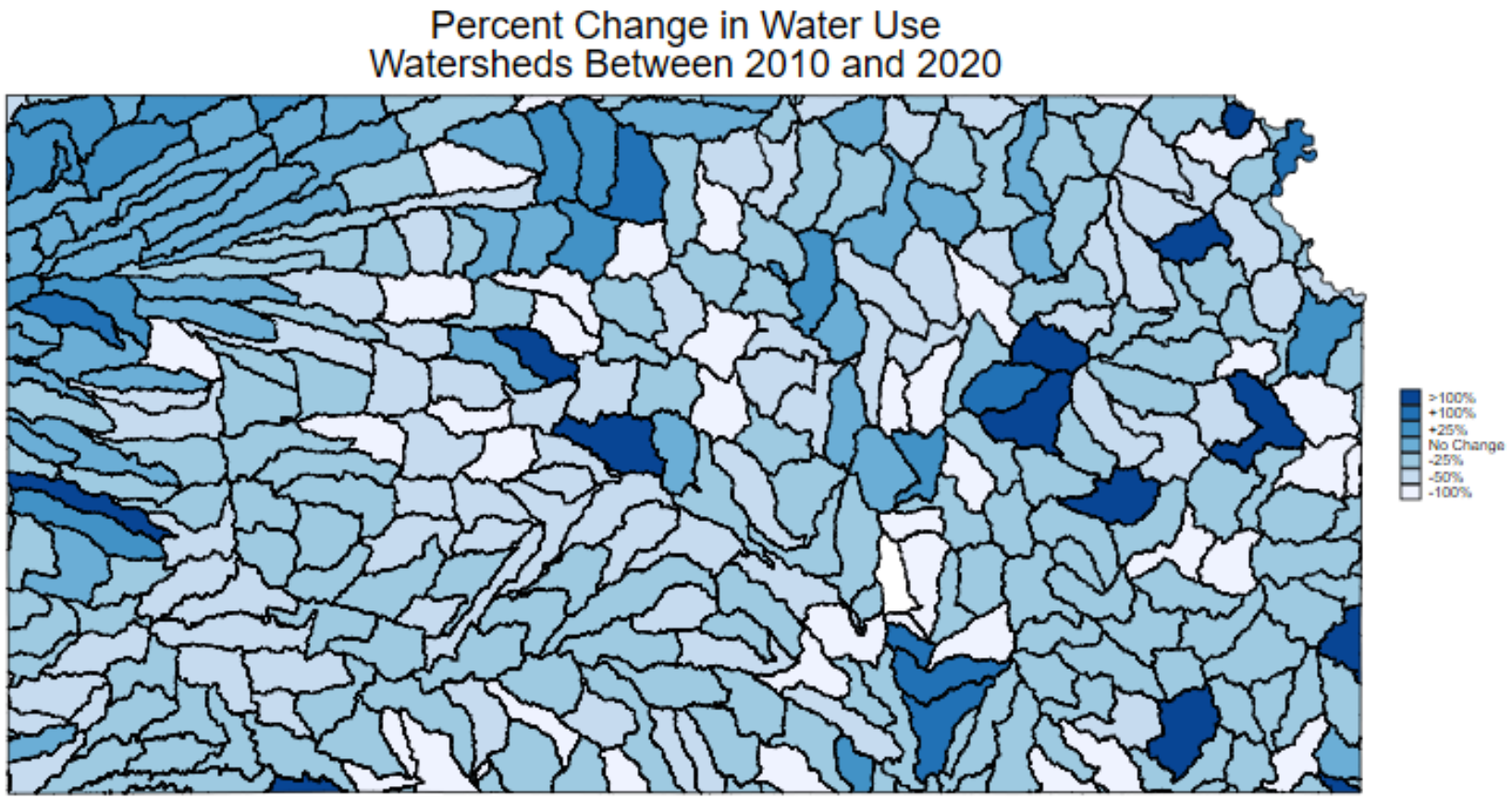
List of those watersheds that saw more than a 100 percent increase

HUC 10 Code	1990 Use	2000 Use	HUC Name
1110010204	2249.95	4789.79	Sharp Creek
1107020302	126.31	268.92	Diamond Creek-Cottonwood River
1026001004	242.79	552.39	Mulberry Creek
1107020202	21.80	51.51	Clear Creek-Cottonwood River
1027010301	50.77	121.60	Muddy Creek-Delaware River
1103000204	461.81	1166.69	Sand Creek
1026000805	10.61	29.10	Turkey Creek
1107010602	9.93	28.18	Upper Caney River
1107020301	2.30	6.98	Middle Creek-Cottonwood River
1025000402	23.79	166.35	Burntwood Creek-Republican River
1026000603	46.80	406.68	Eagle Creek-Smoky Hill River
1103001803	4.37	80.61	Rock Creek-Walnut River
1025001701	2.49	109.87	Marsh Creek-Buffalo Creek
1026000301	.092	17.42	Sixmile Creek-Smoky Hill River
1026001002	.059	99.57	Spillman Creek-Saline River

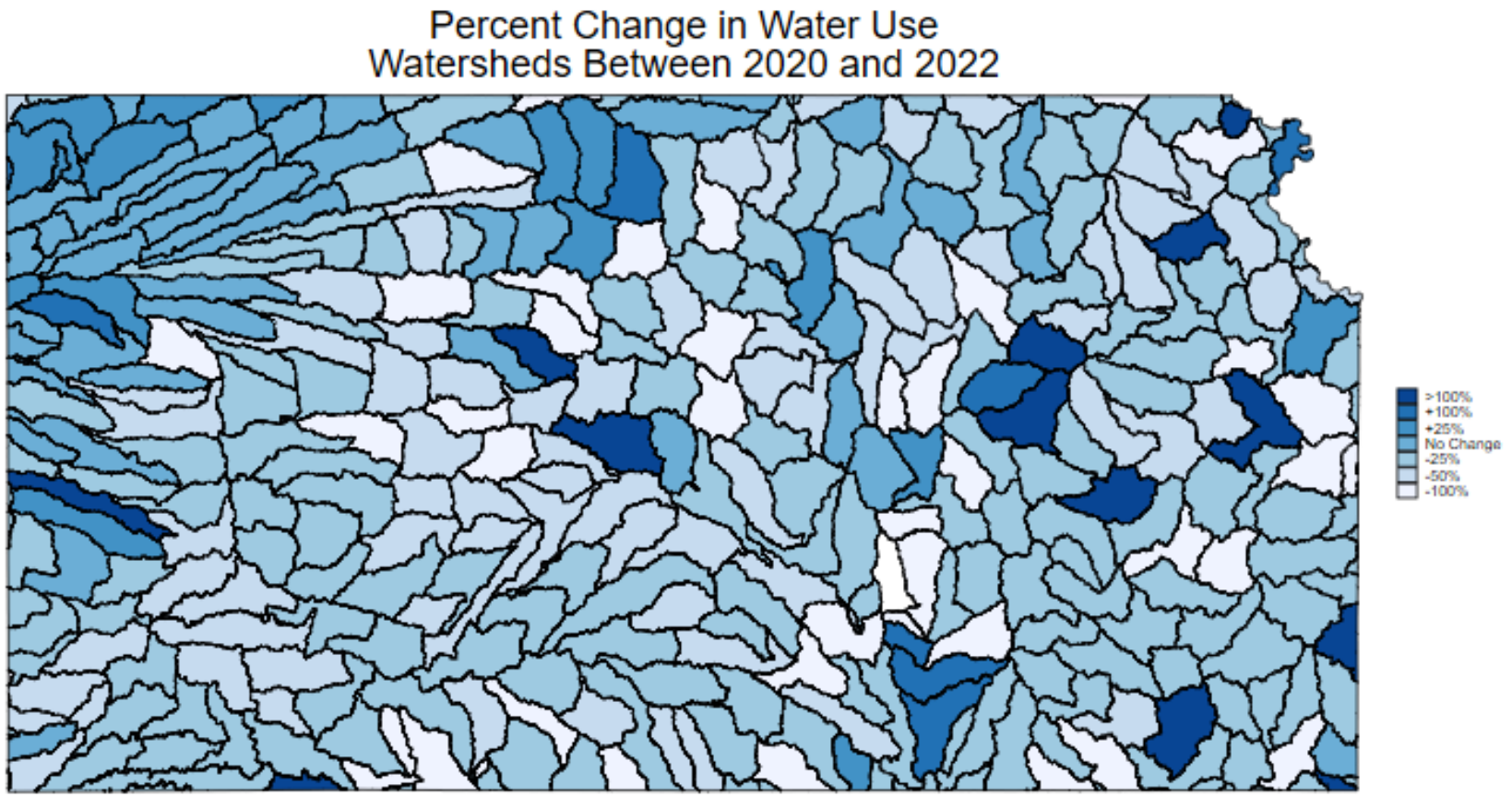
Percent change in water use by watershed: 2000 - 2010



Percent change in water use by watershed: 2010 - 2020



Percent change in water use by watershed: 2020 - 2022



WIZARD measurements

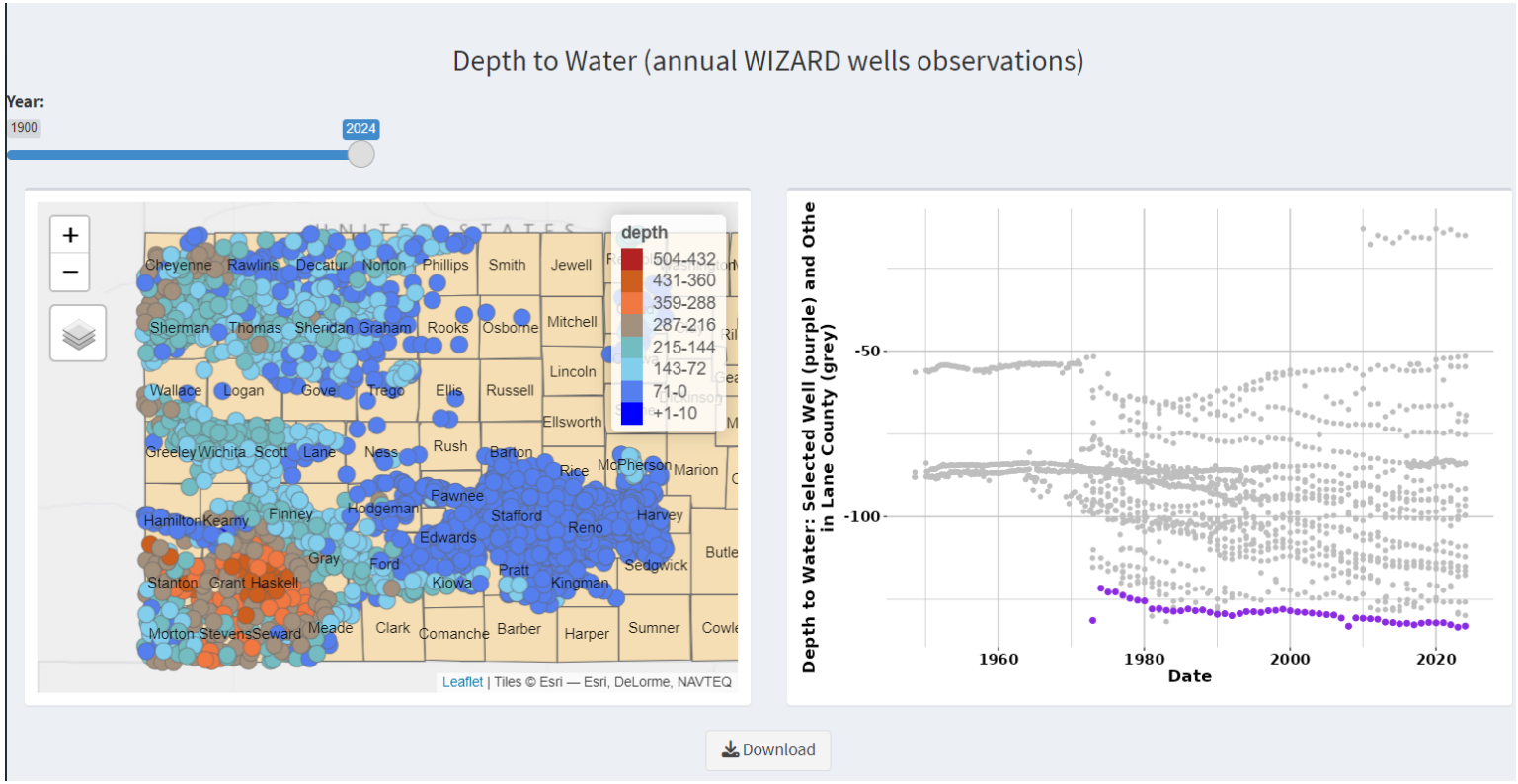
WIZARD measurements look at well depth for a set of wells across parts of Kansas.

- 7,821 unique wells that were scraped from the WIZARD well database maintained by the Kansas Geological Survey.
- Over time, these 7,821 unique wells have been measured 627,522 times.
- The earliest recorded observation in the scraped data is in 1900 and latest is in 2024.

WIZARD measurement sources

Blank	361,461	57.60	57.60
City of Wichita	11,370	1.81	59.41
DWR	84,967	13.54	72.95
GMD1	2	0.00	72.95
GMD2	81,127	12.93	85.88
GMD3	1	0.00	85.88
GMD4	134	0.02	85.90
GMD5	42,976	6.85	92.75
KCC	20	0.00	92.75
KDHE	38	0.01	92.76
KGS	18,389	2.93	95.69
KU	4	0.00	95.69
KWO	6	0.00	95.69
SG	12	0.00	95.69
USGS	27,015	4.31	100

A sneak peak of the dashboard



Groundwater interactive visualizations link

Future work to complete dashboard

Do more to contextualize water use. Some of this we have already discussed (water rights and aquifer recharge):

1. Other contextual information might be population size, number of irrigated acres, number of irrigators, etc.

There are a number of voluntary cost-share and/or incentive-based programs to persuade (mostly agricultural) users to use less water.

1. Incorporate land use data from KDA

If we look at water use granularly, it could be insightful to connect the use data with annual rainfall or drought data.

1. Incorporate PRISM or MESONET data with WIMAS.

Questions and Feedback

Thank you for your survey responses