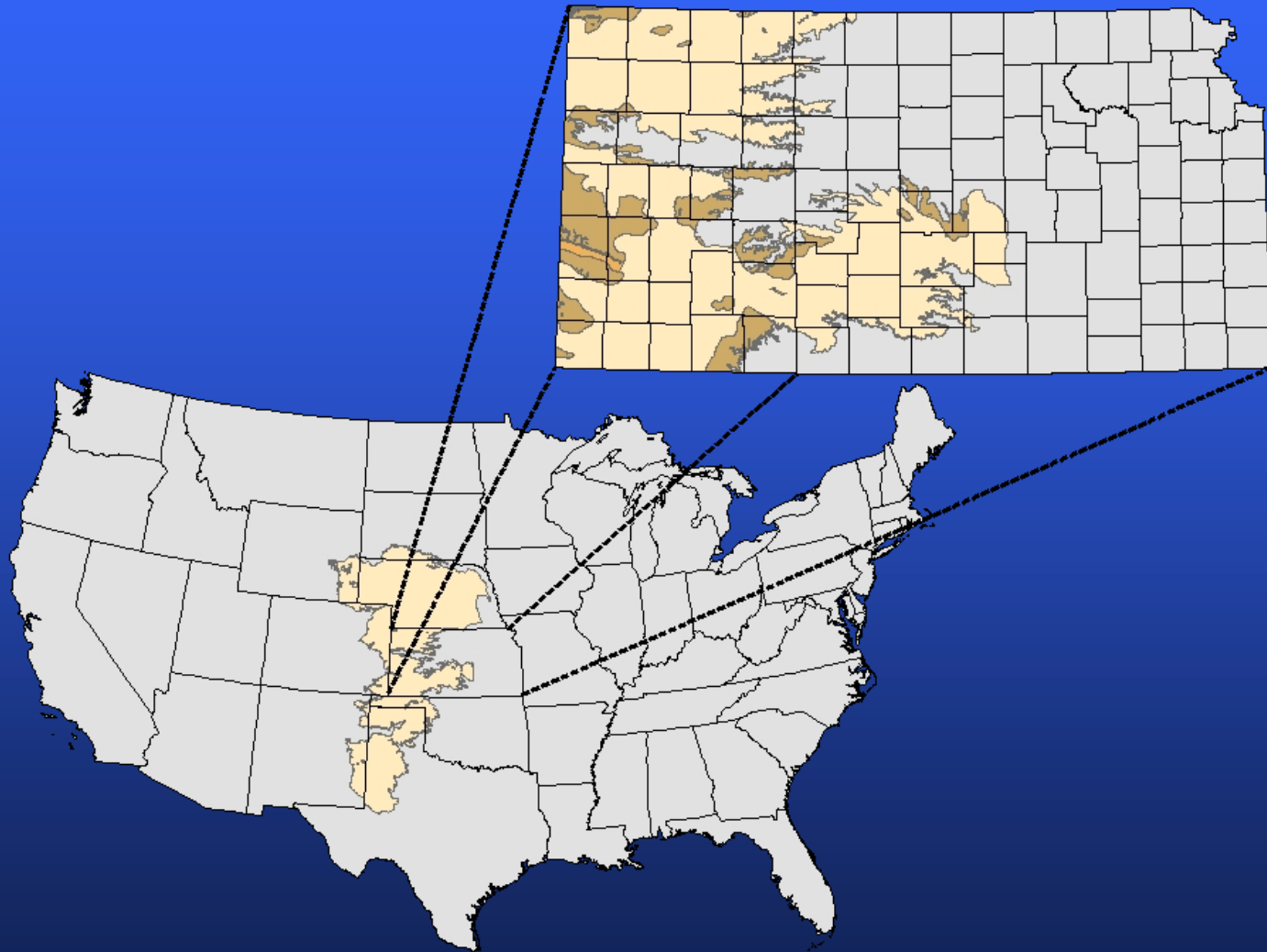


Hydrology and Water Quality of the Arkansas River Basin in Southwest Kansas

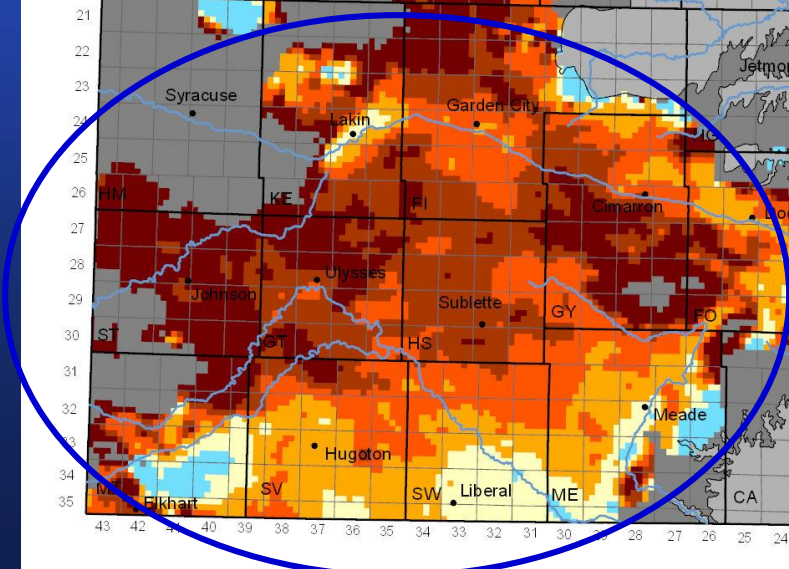
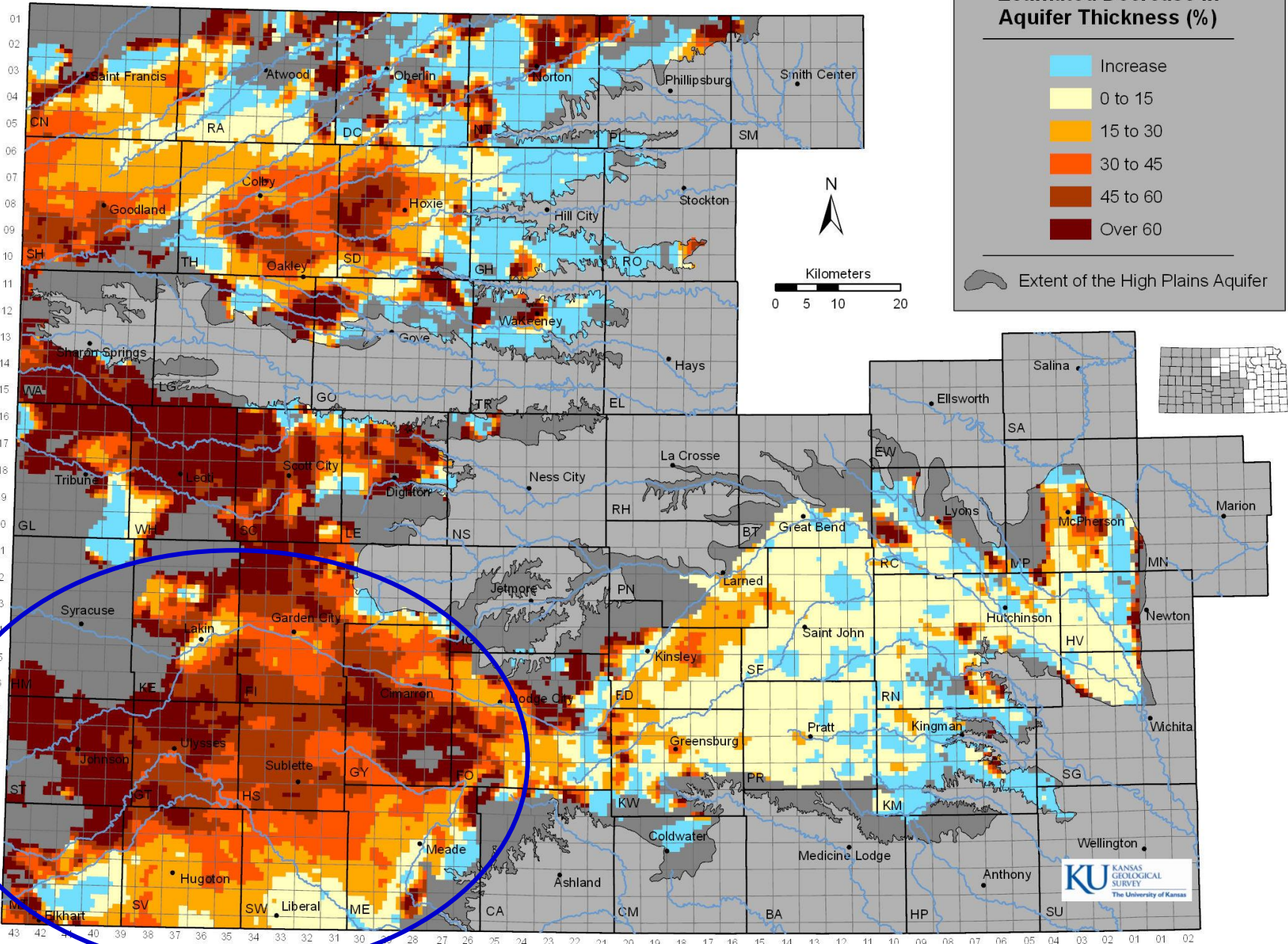
Jim Butler, Don Whittemore,
and Brownie Wilson
Kansas Geological Survey
University of Kansas

Upper Arkansas Regional Advisory Committee
Garden City, Kansas
April 12, 2019

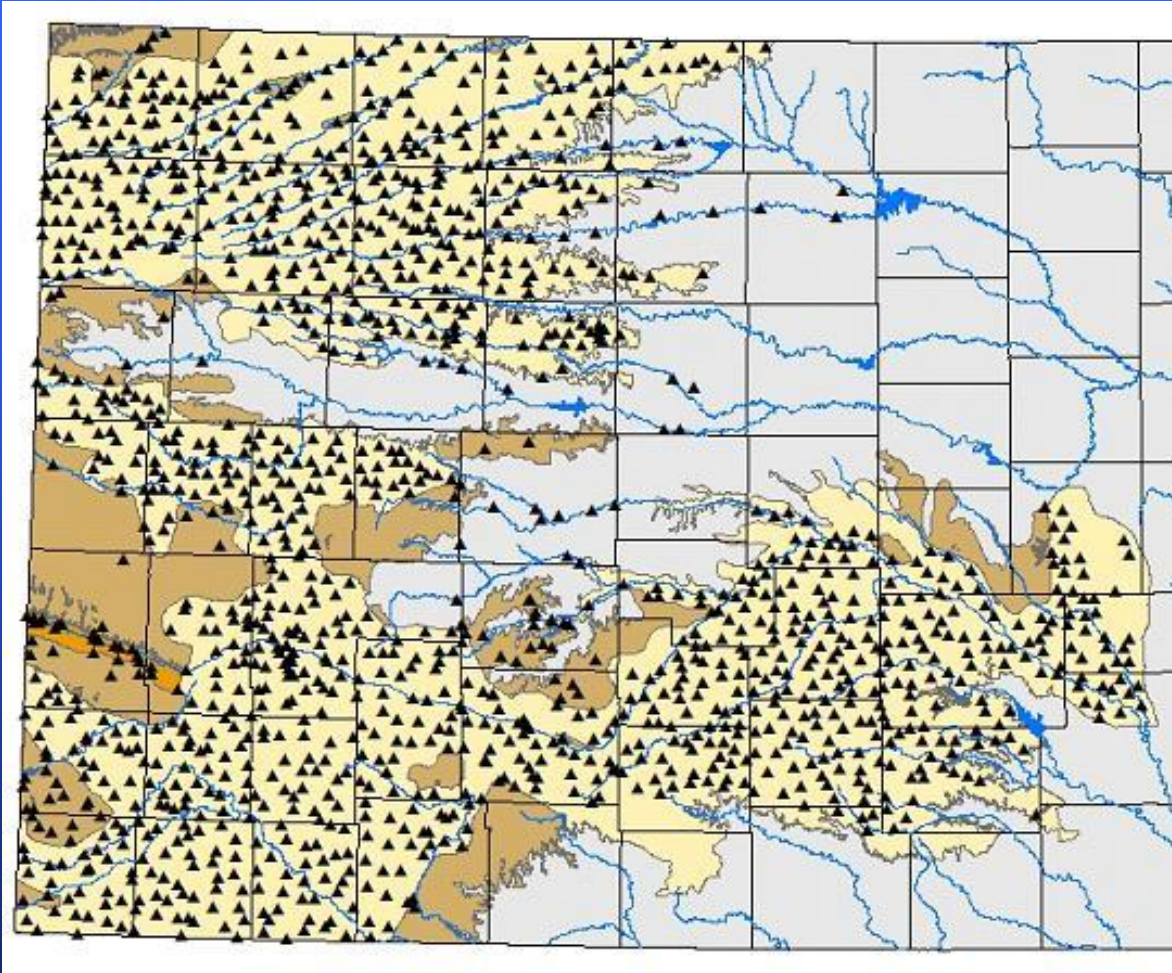
The High Plains Aquifer



Percent Change in Aquifer Thickness, Predevelopment to Average 2016-2018, Kansas High Plains Aquifer



Annual Water Level Measurement Program

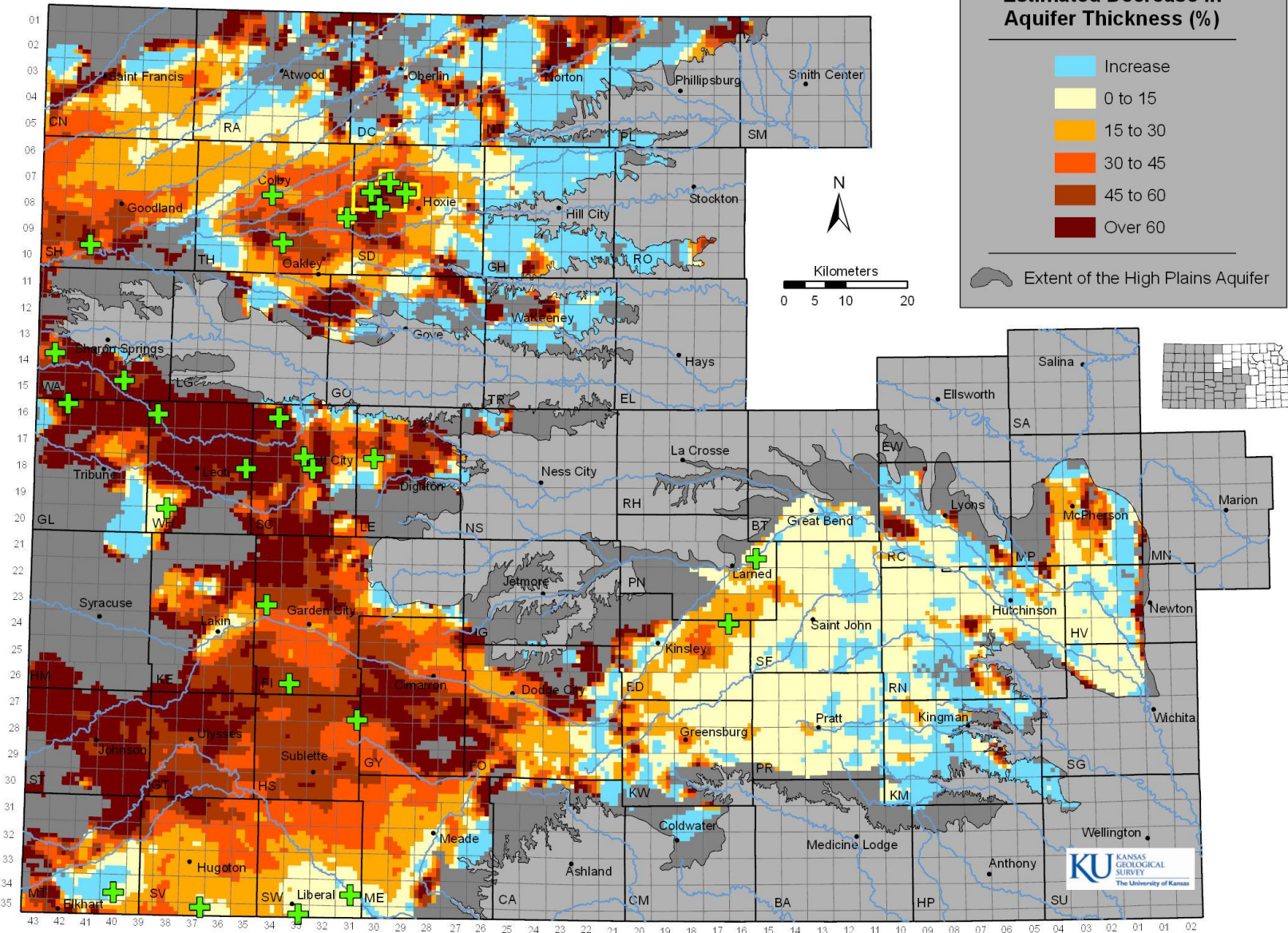


≈1400 wells measured in High Plains aquifer in 2019

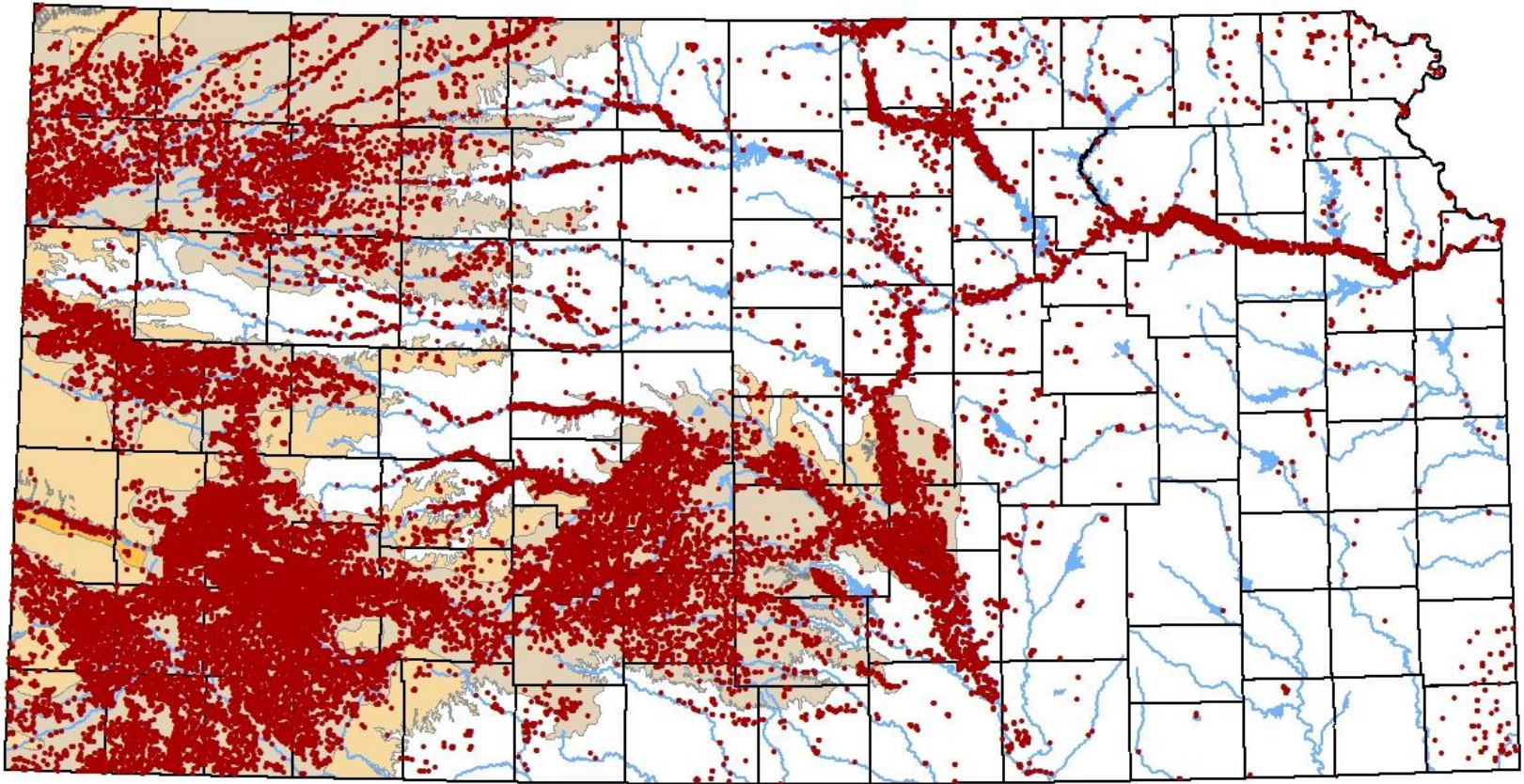
- http://www.kgs.ku.edu/HighPlains/HPA_Atlas/index.html

Index Well Program - 29 wells with continuous recorders

Percent Change in Aquifer Thickness, Predevelopment to Average 2016-2018, Kansas High Plains Aquifer

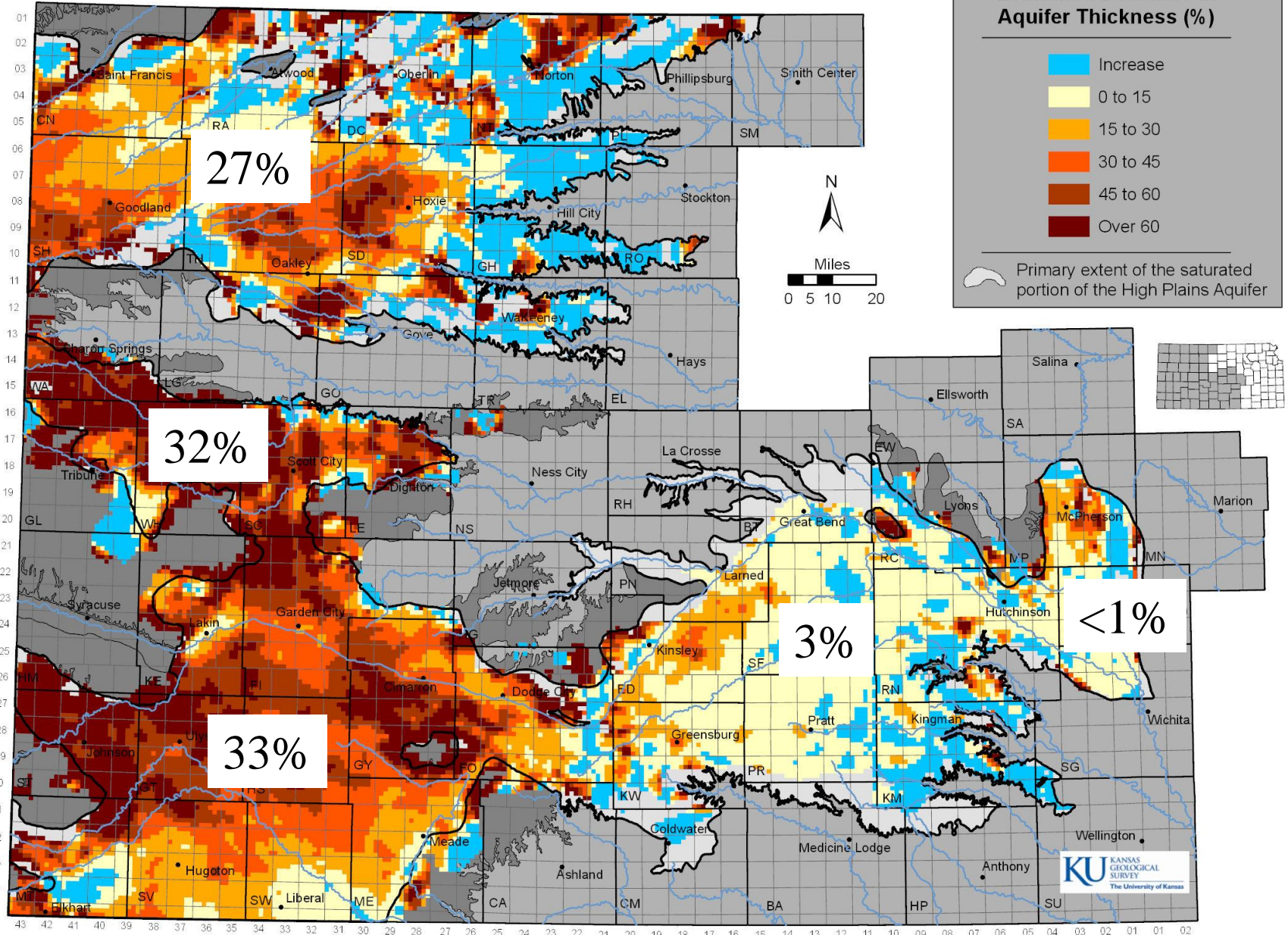


Annual Water Use Data

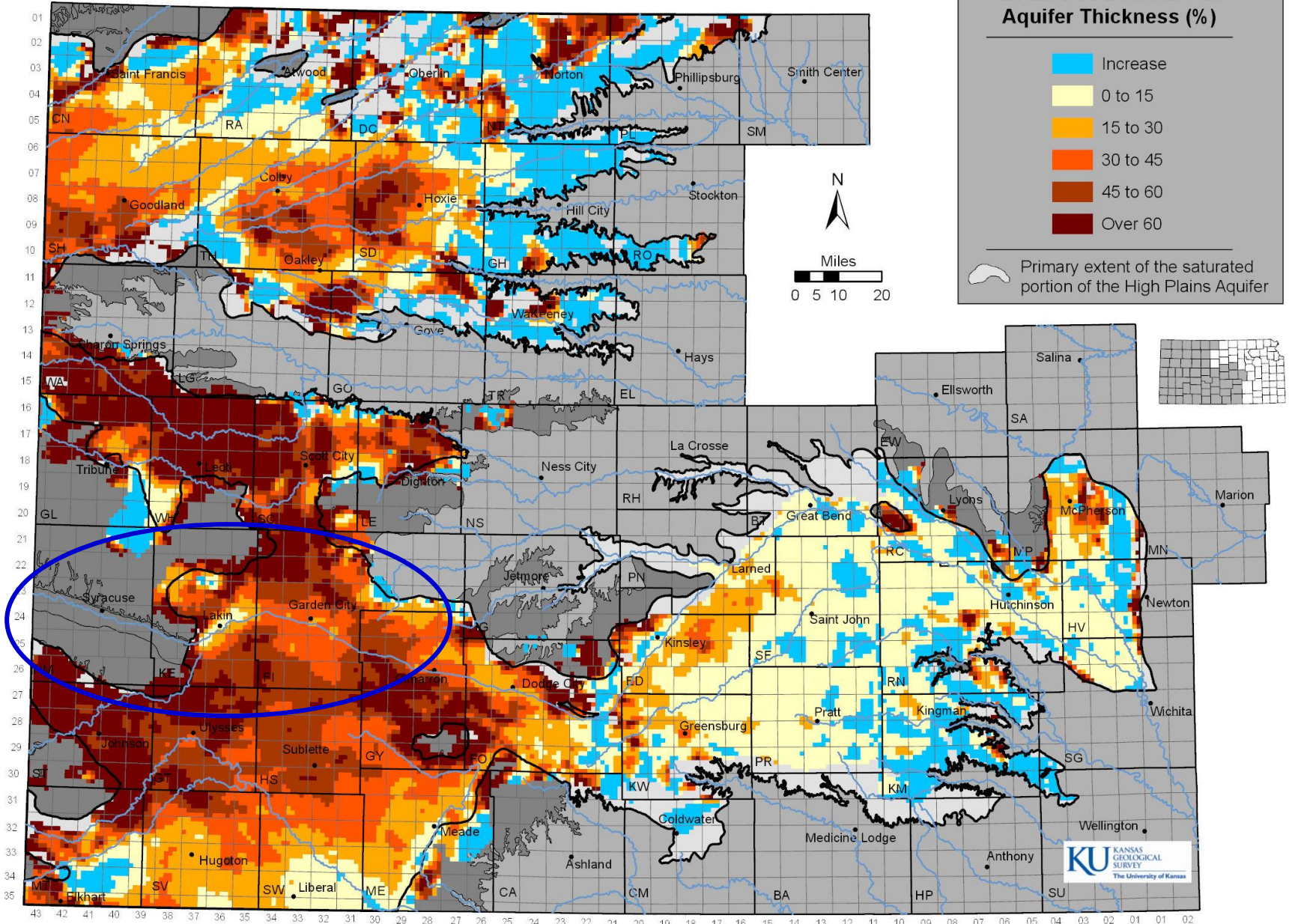


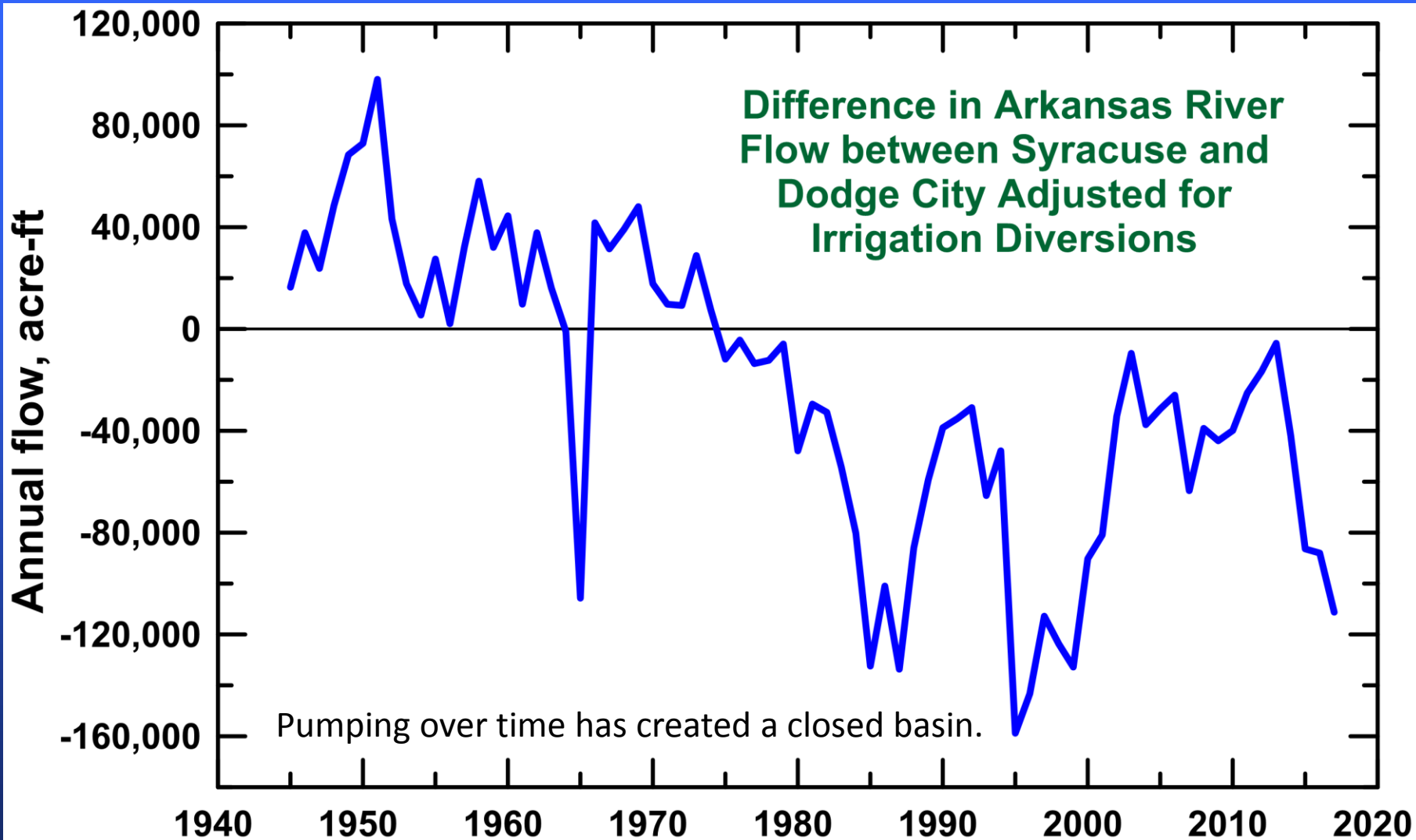
$\approx 27,700$ wells with totalizing flowmeters in High Plains aquifer
(over 95% of non-domestic pumping wells)

Percent Change in Aquifer Thickness, Predevelopment to Average 2016-2018, Kansas High Plains Aquifer

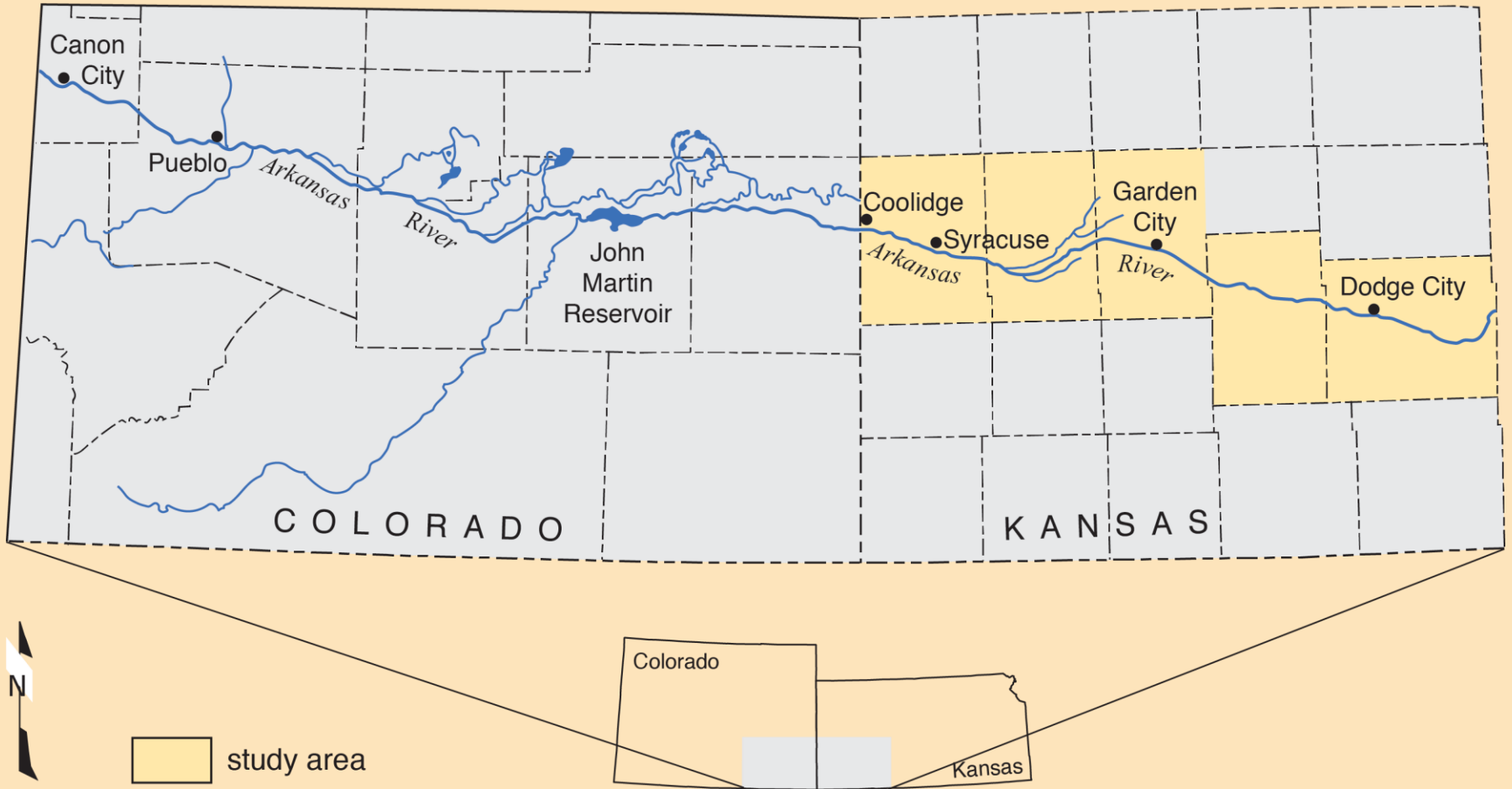


Percent Change in Aquifer Thickness, Predevelopment to Average 2016-2018, Kansas High Plains Aquifer

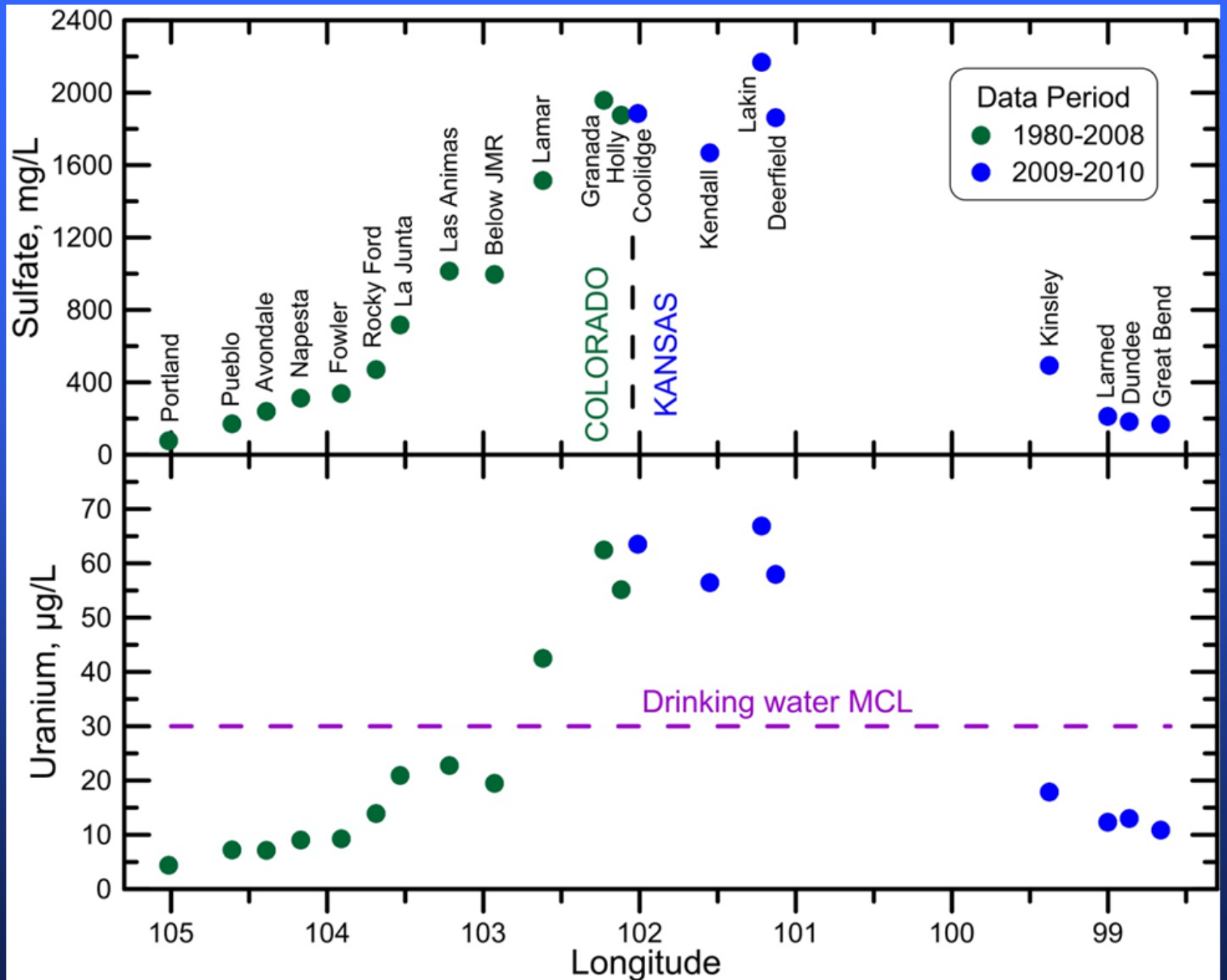




Natural Drainage and Irrigation Canals in the Upper Arkansas River Basin



Evapotranspiration in the area of irrigation diversions and reservoirs in eastern Colorado substantially decreases the river flow before it enters Kansas. A smaller extent of irrigation ditches also divert river water in southwest Kansas.



Estimated 10 tons of uranium in 2017.

SOURCE OF SALINITY AND URANIUM IN RIVER

Main natural source: Weathering of marine Cretaceous shales containing gypsum and sulfides in Colorado.

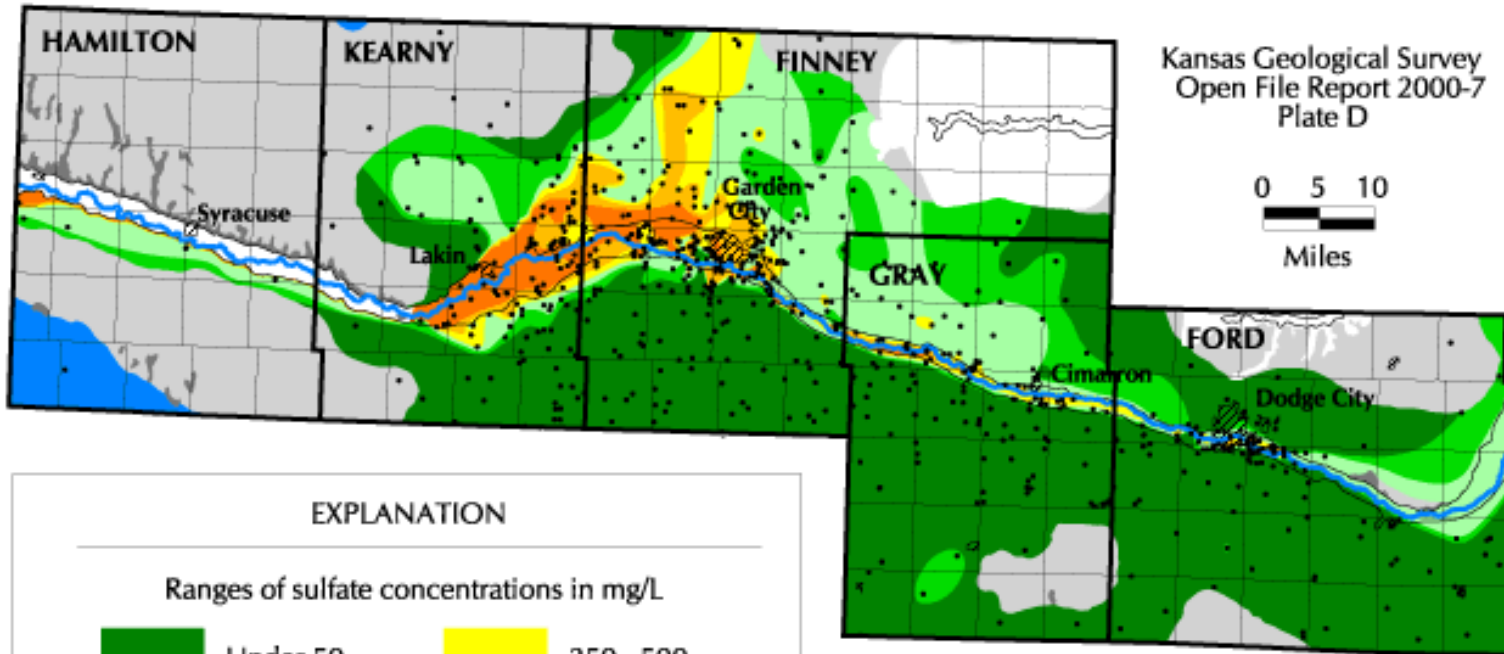
Human sources: Insignificant.

CAUSE OF HIGH SALINITY AND URANIUM LEVELS

Human: Concentration of dissolved salts by consumption of water by evapotranspiration associated with extensive irrigated agriculture and shallow reservoirs.

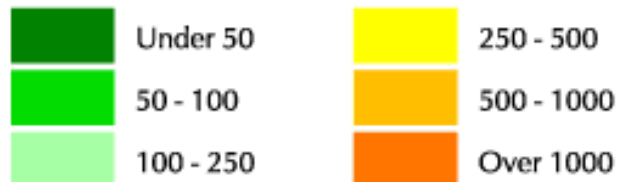
Natural: In absence of human activities, salinity and uranium concentration would be 3 to 4 times lower.

Sulfate Concentration for the High Plains Aquifer in the Upper Arkansas River Corridor in Southwest Kansas

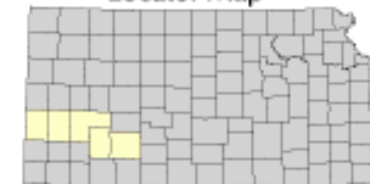





EXPLANATION

Ranges of sulfate concentrations in mg/L






Locator Map

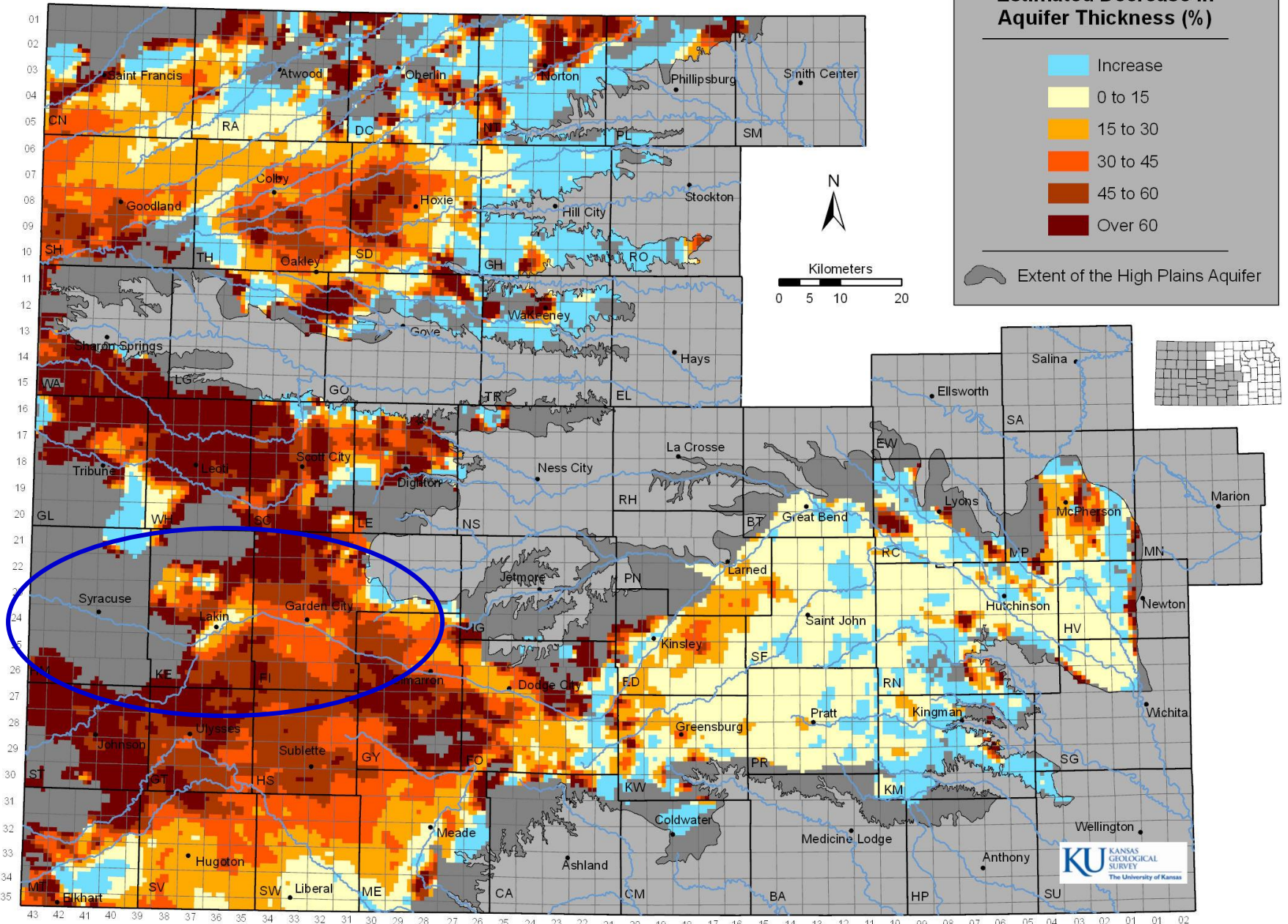


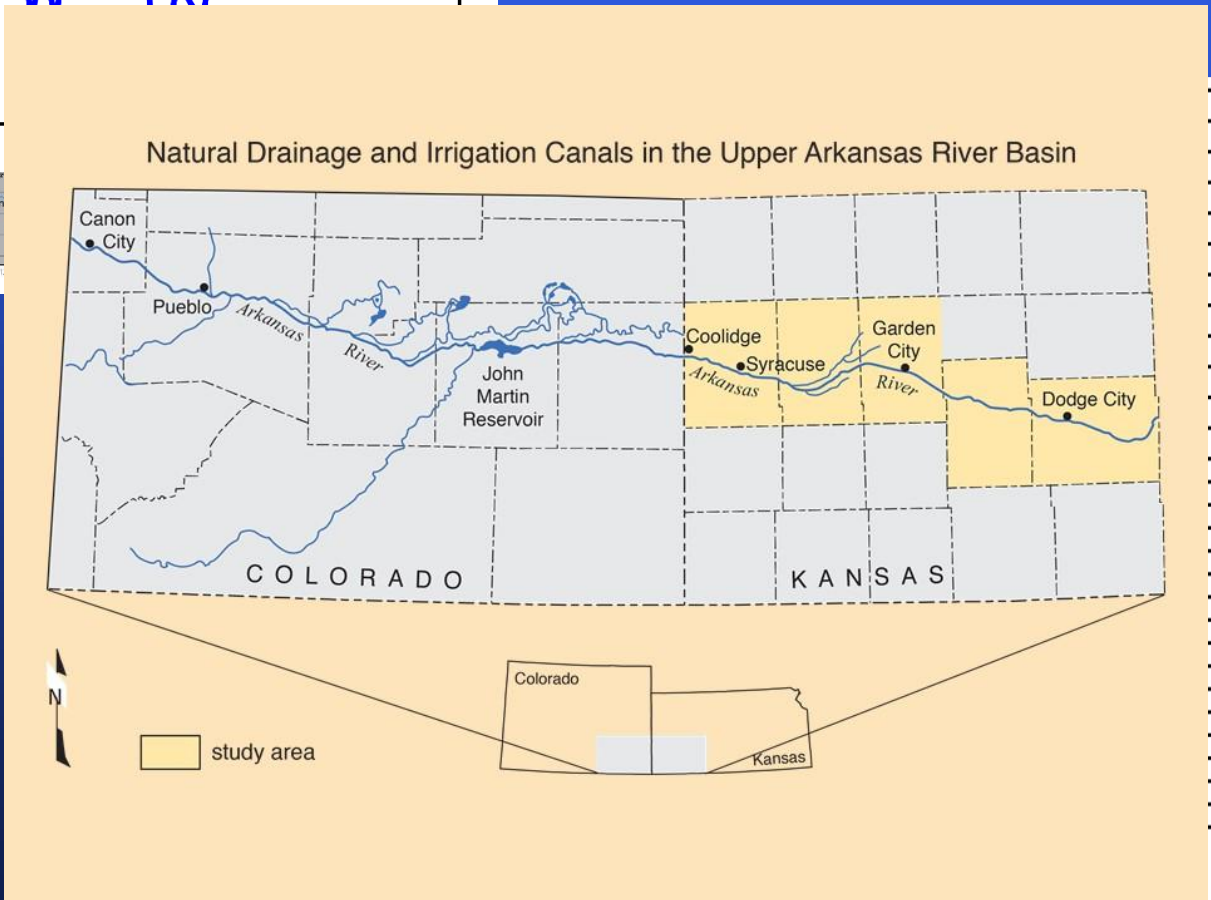
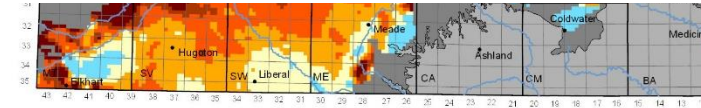
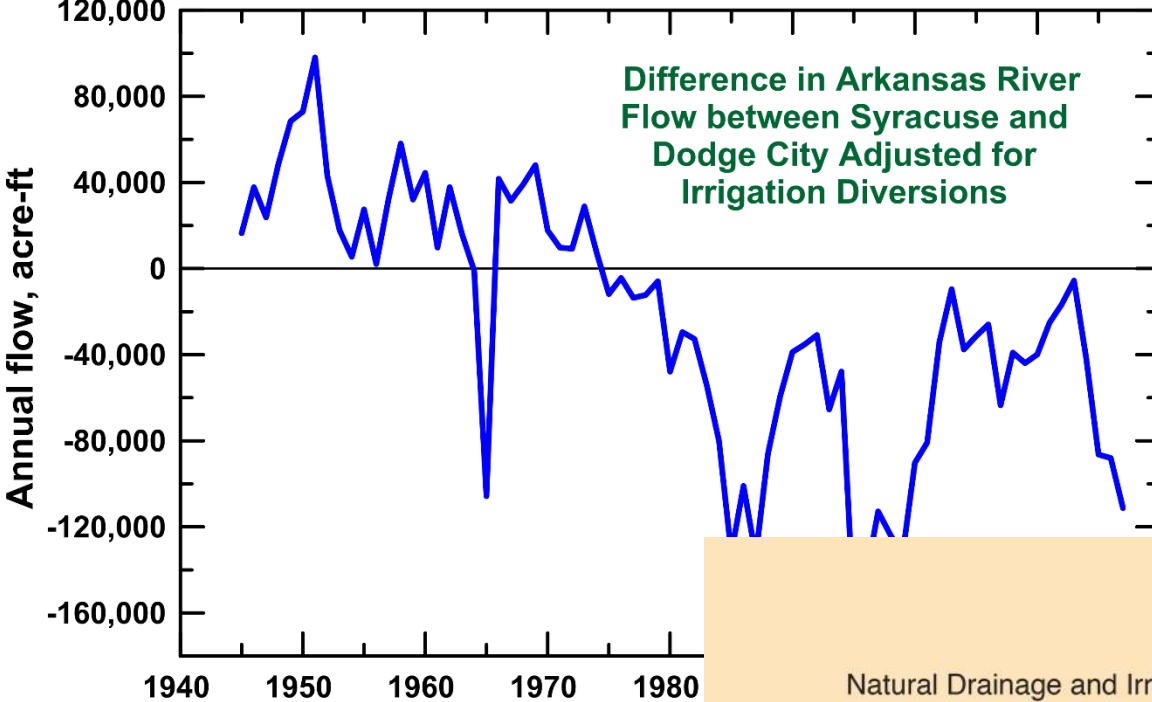
-  Wells with water quality samples
-  Arkansas River
-  Quaternary alluvium

High Plains aquifer extent:

-  Area of little or no saturated thickness
-  Missing aquifer due to outcrop of older rocks
-  Area having some saturated thickness where sulfate concentrations are not shown

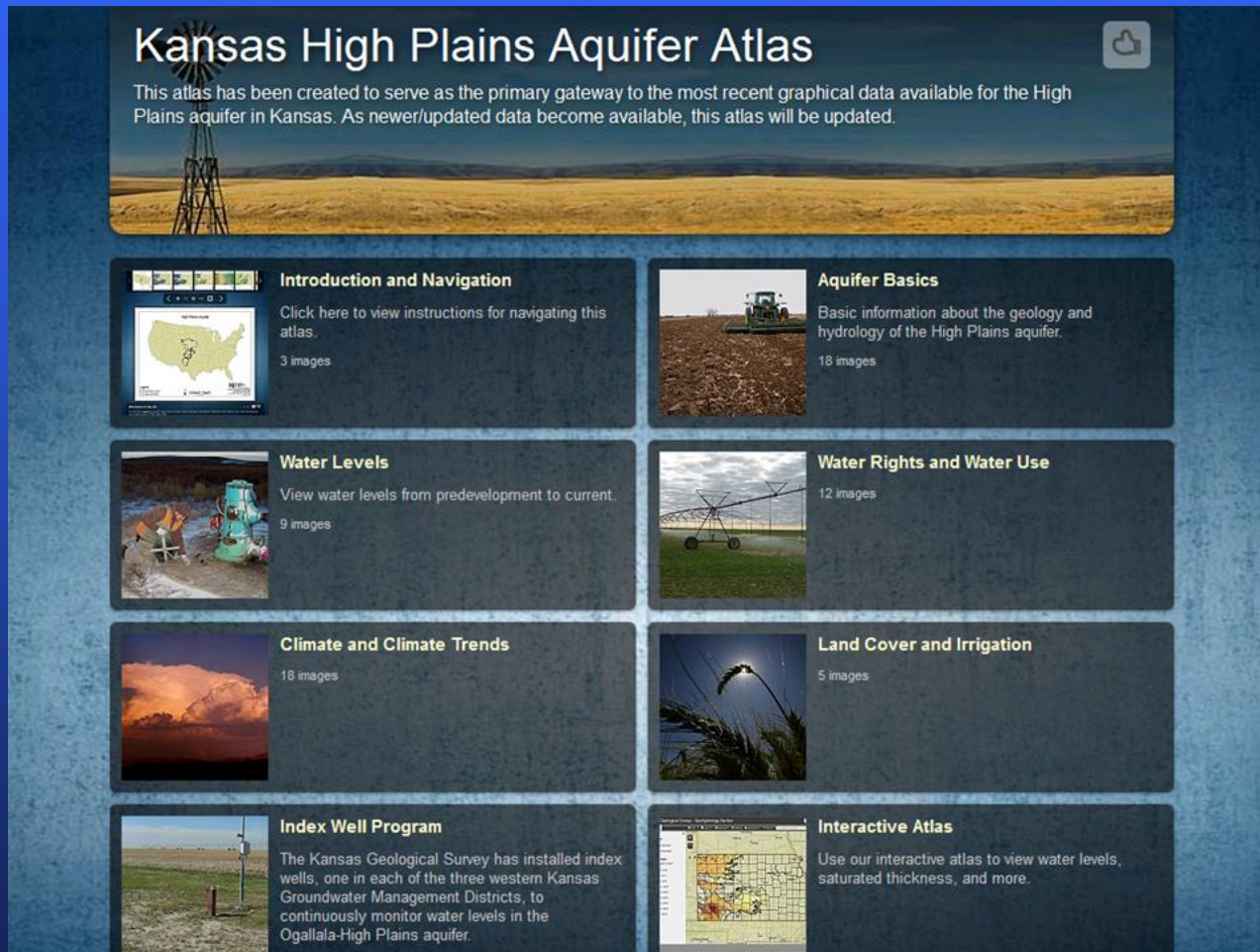
Percent Change in Aquifer Thickness, Predevelopment to Average 2016-2018, Kansas High Plains Aquifer





ACKNOWLEDGMENTS

This work was supported, in part, by funding from the Kansas Water Office and the Kansas Water Plan (Ogallala Technical Support Program of the KGS).



The screenshot displays the homepage of the Kansas High Plains Aquifer Atlas. At the top, a banner features a windmill in a field with the title "Kansas High Plains Aquifer Atlas" and a thumbs-up icon. Below the banner is a descriptive paragraph. The main content area is a grid of ten interactive tiles, each with a representative image, a title, a brief description, and the number of images available in that section.

| Section Title | Description | Number of Images |
|------------------------------------|---|------------------|
| Introduction and Navigation | Click here to view instructions for navigating this atlas. | 3 images |
| Aquifer Basics | Basic information about the geology and hydrology of the High Plains aquifer. | 18 images |
| Water Levels | View water levels from predevelopment to current. | 9 images |
| Water Rights and Water Use | | 12 images |
| Climate and Climate Trends | | 18 images |
| Land Cover and Irrigation | | 5 images |
| Index Well Program | The Kansas Geological Survey has installed index wells, one in each of the three western Kansas Groundwater Management Districts, to continuously monitor water levels in the Ogallala-High Plains aquifer. | |
| Interactive Atlas | Use our interactive atlas to view water levels, saturated thickness, and more. | |

http://www.kgs.ku.edu/HighPlains/HPA_Atlas/index.html

RELEVANT REPORTS

Fate of high uranium in saline Arkansas River water in southwest Kansas:
Distribution in soils, crops, and groundwater: 2016 Report for Kansas
Water Resources Institute, by D.O Whittemore, J. Aguilar, et al.

Open-file Rept. 2017-32, Estimated annual uranium loads in the Arkansas
River entering Kansas 2012-2016: Kansas Geological Survey, available at
www.kgs.ku.edu/Hydro/Publications/2017/OFR17_2/index.html

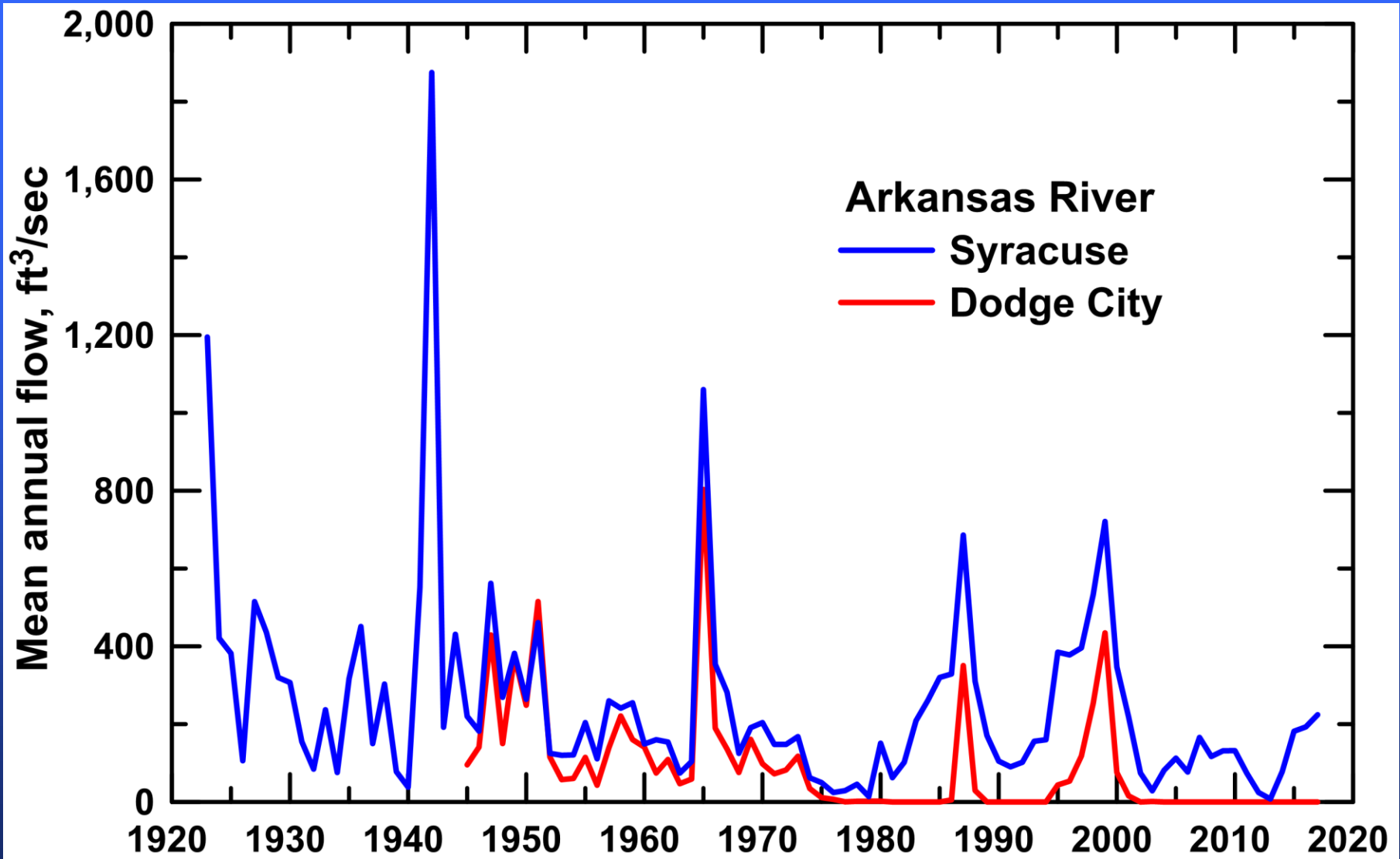
Open-file Rept. 2000-73, Ground-water quality of the Arkansas
River Corridor in southwest Kansas, by D.O. Whittemore

Open-file Rept. 2000-72, Sulfate concentration maps, Upper
Arkansas River Corridor, southwest Kansas, by D. O. Whittemore

Open-file Rept. 2000-44, Water quality of the Arkansas River in
southwest Kansas, by D.O. Whittemore

***Last three reports available on KGS web pages for
Upper Arkansas River Corridor Study***

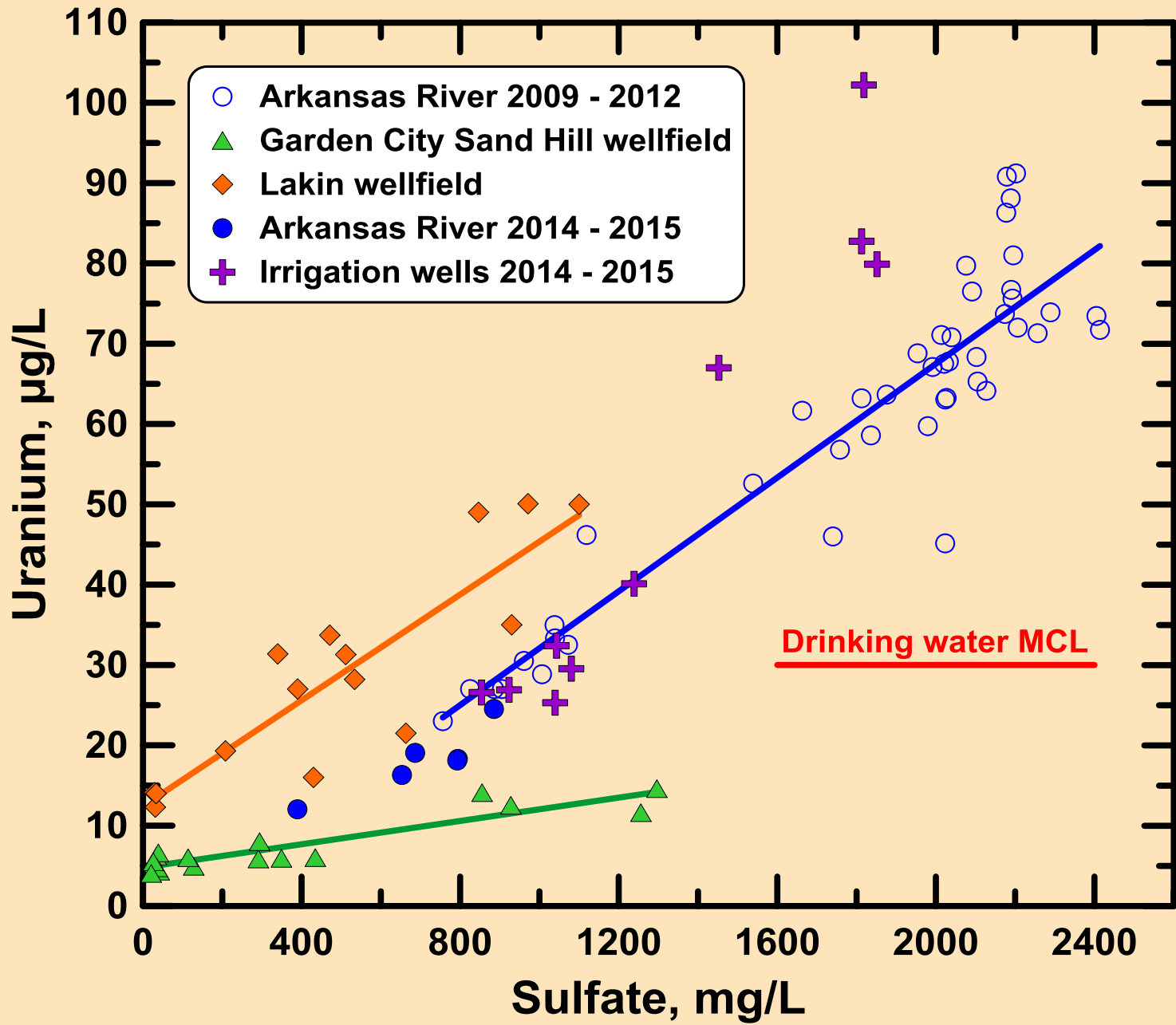
<http://www.kgs.ku.edu/Hydro/UARC/index.html>

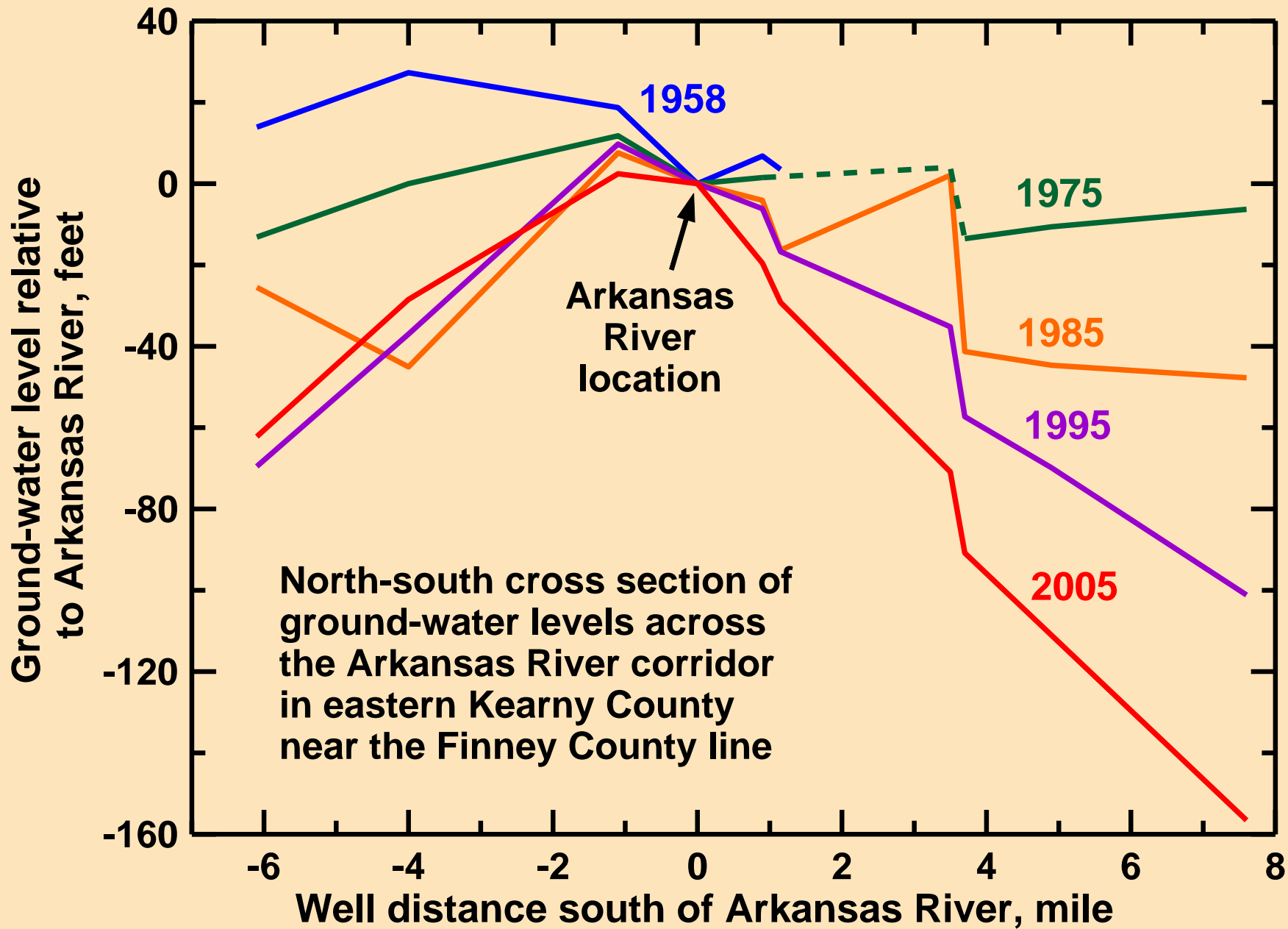


Arkansas River near Colorado-Kansas Line

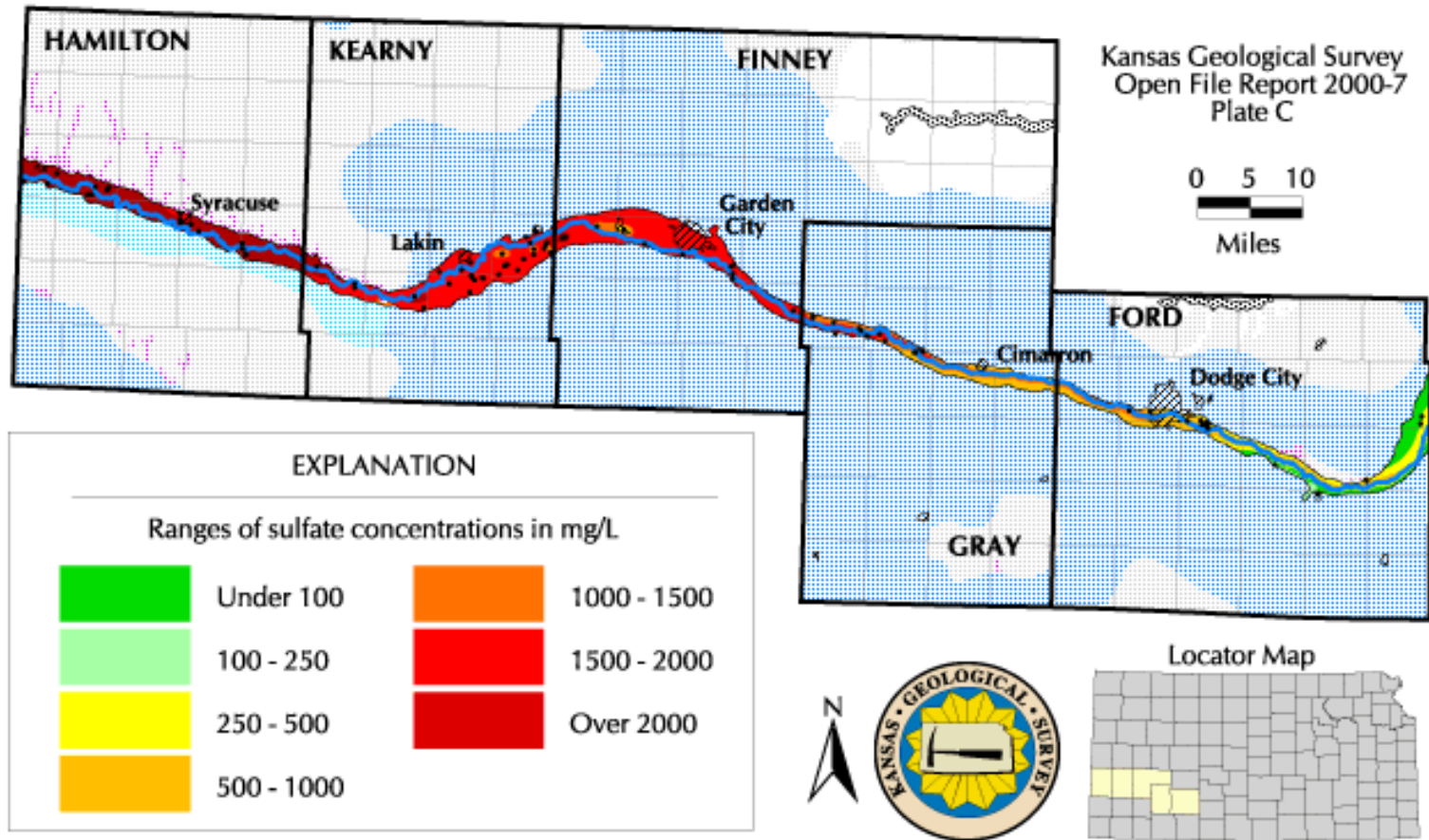
1963-2010 for all data except 2009-2010 for U

| | Flow ft ³ /sec | TDS mg/L | SO ₄ mg/L | Cl mg/L | U μg/L | Gross α pCi/L |
|--|------------------------------|--------------|-------------------------|--------------|-------------|---------------------|
| Average | 244 | 3,260 | 1,960 | 137 | 63.5 | 57.6 |
| Number of samples | 554 | 486 | 553 | 551 | 27 | 36 |
| Drinking water standard, MCL or (recommended) | - | (500) | (250) | (250) | 30 | 15 |





Sulfate Concentration for the Quaternary Alluvial Aquifer in the Upper Arkansas River Corridor in Southwest Kansas



• Wells with water quality samples

Arkansas River

Quaternary alluvium where sulfate concentrations are not shown

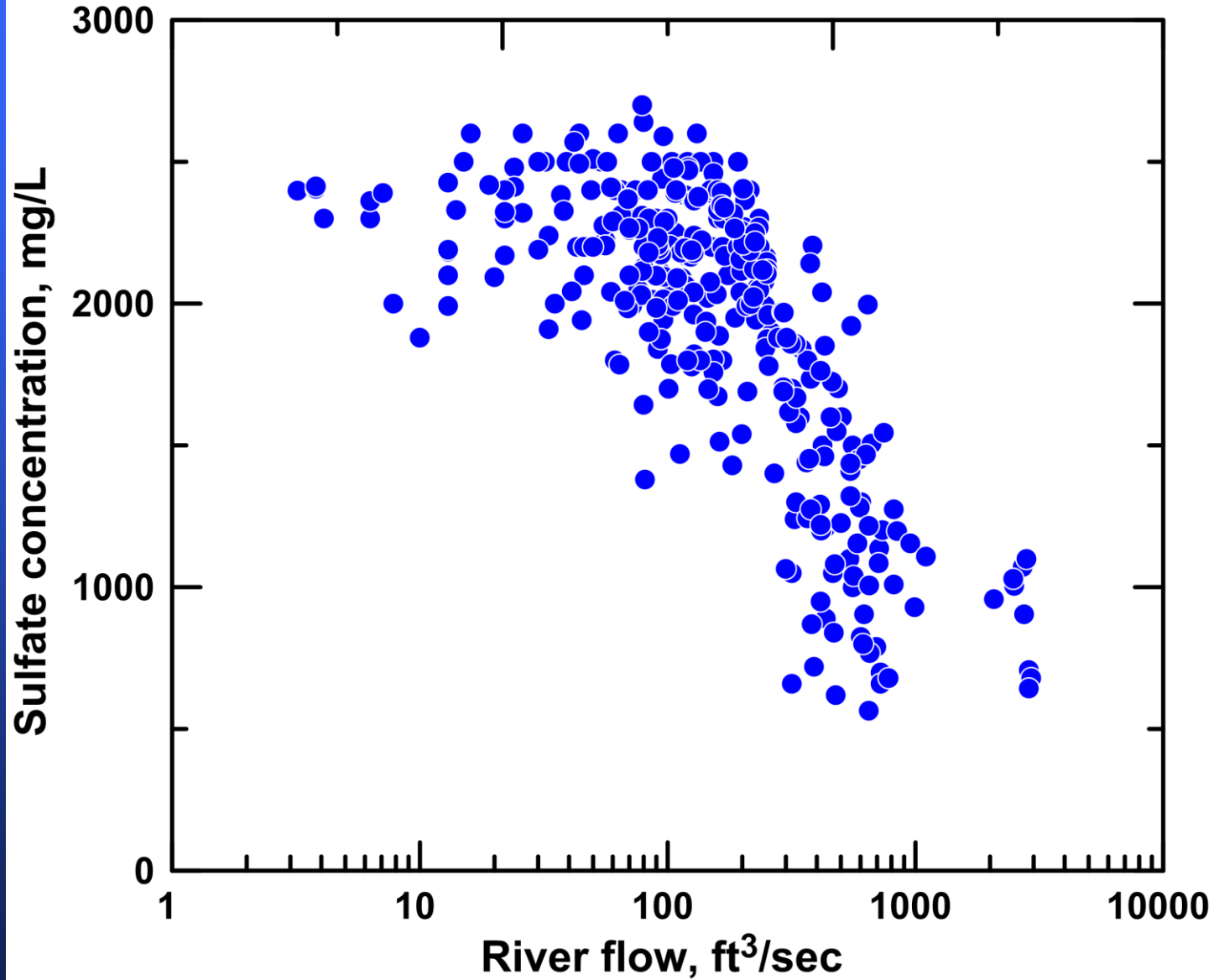
High Plains aquifer extent:

Area of little or no saturated thickness

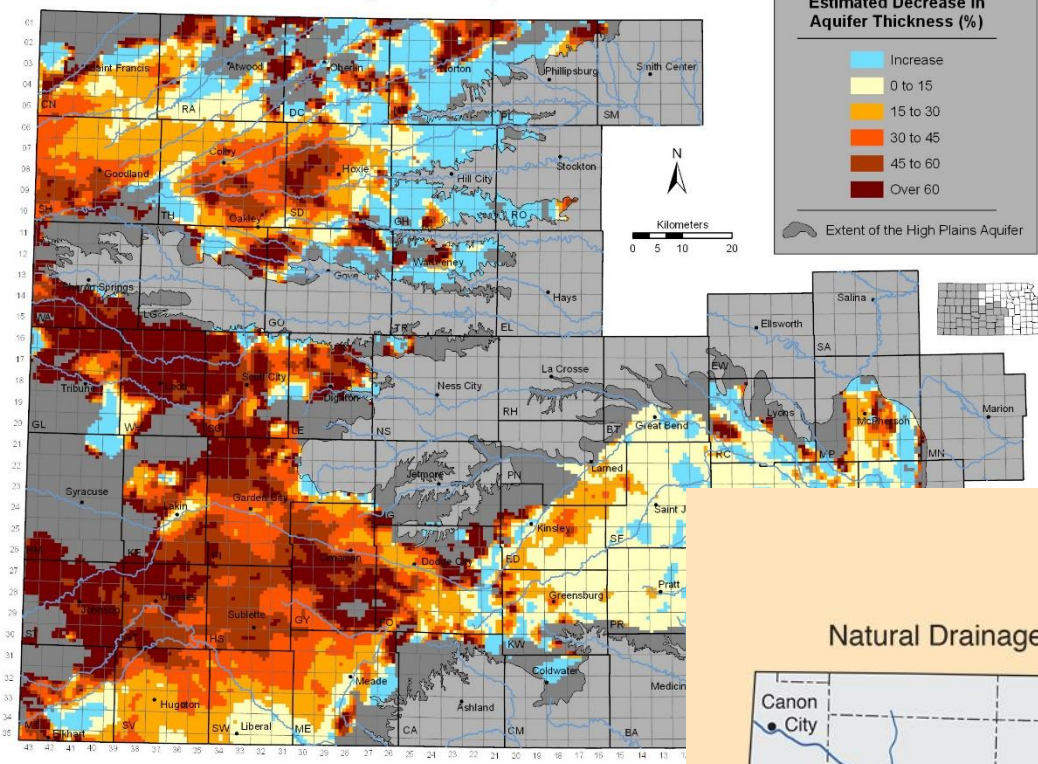
Missing aquifer due to outcrop of older rocks

Area having some saturated thickness where sulfate concentrations are not shown

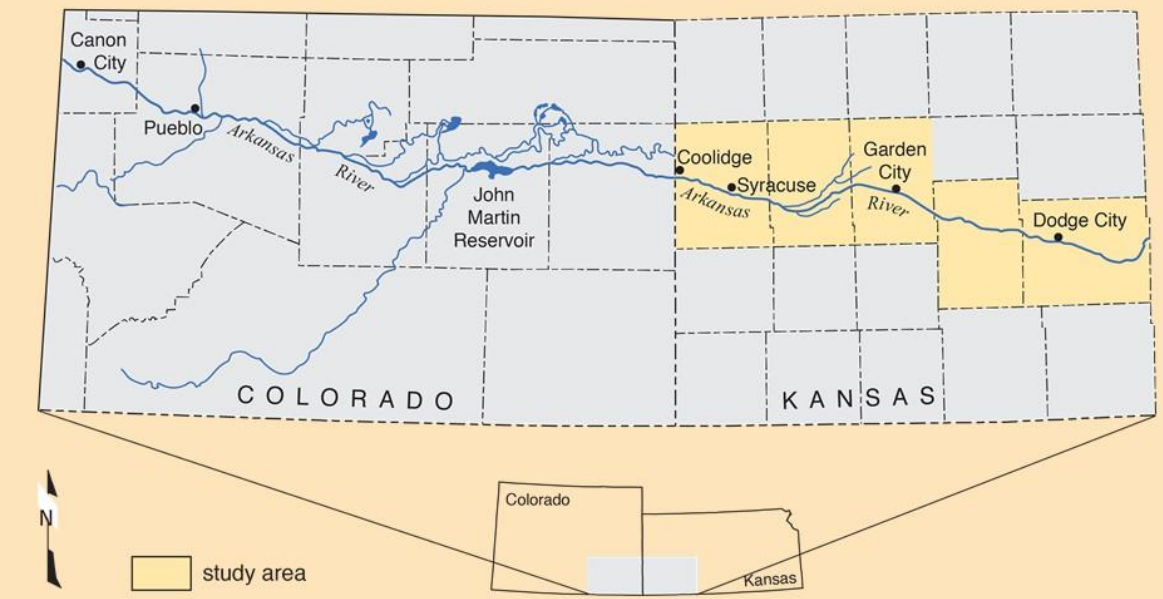
Arkansas River near Coolidge since 1980



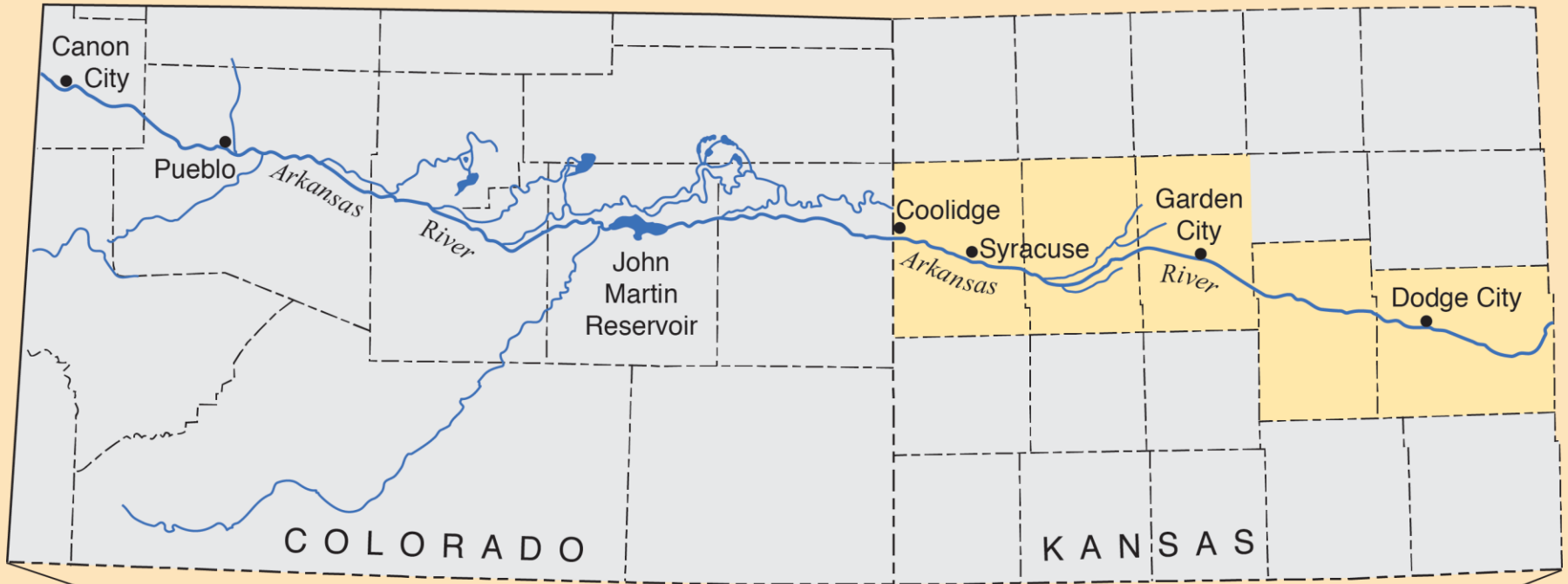
Percent Change in Aquifer Thickness, Predevelopment to Average 2016-2018, Kansas High Plains Aquifer




Natural Drainage and Irrigation Canals in the Upper Arkansas River Basin



Natural Drainage and Irrigation Canals in the Upper Arkansas River Basin



 study area

