RAINFALL-RUNOFF ANALYSIS FOR THE LOWER KANSAS WATERSHED

Olive Olson

March 19th, 2021

Water Resource Analysis

RAINFALL-RUNOFF ANALYSIS FOR THE LOWER KANSAS WATERSHED

A. BENEFICIARIES

The people who use the water in the Lower Kansas Watershed, including the counties of Atchison, Jefferson, Leavenworth, Wyandotte, Johnson, Douglas, Osage, Jackson, and a very small part of Wabaunsee are the primary beneficiary of the proposed project. The Kansas Department of Health and Environment, in particular the Bureau of Water, the Kansas Department of Wildlife, Parks & Tourism, and the Kansas Geological Survey are the main state agencies involved in the watershed, as well Inter-State Organizations such as the Interstate Council on Water Policy and American Water Works Association.

B. PROJECT DESCRIPTION

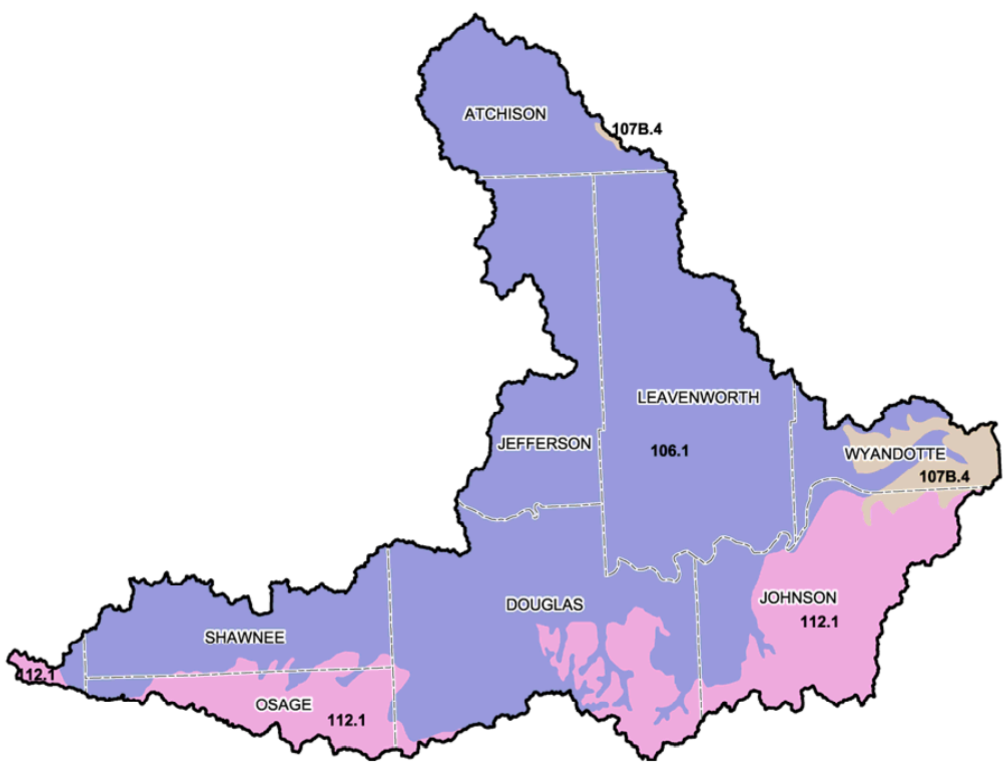
A. EXECUTIVE SUMMARY

The rainfall-runoff analysis plans to evaluate how the average amount of rainfall compares with the average runoff in Lower Kansas watershed. This will help show where action needs to be taken in order to optimize water availability.

B. PROJECT DESCRIPTION

The project area is an approximately 1,056,000-acre plot located in the northeast region of Kansas, called the Lower Kansas Watershed.

Common Resource Area (CRA) Map/1



1. ALTERNATIVE TO THE PROPOSED PROJECT

There were two design objectives analyzed when considering the alternatives: to evaluate the amount of rainfall versus runoff for my project area, and to be able to use that information to make changes in the future to support the water resource. Based on those objectives, the following alternatives were considered.

Alternative 1

Alternative 1 is conduct a rainfall-runoff analysis.

Alternative 2

Alternative 2 is create model of change over time to predict future water resource issues

No Action Alternative

A No Action Alternative was considered as an environmental baseline. Citizens wouldn't understand their water situation and the authority wouldn't be able to change things for better. Lack of up-to-date info could impact stakeholders (farmers, citizens who depend on water in area)

C. AFFECTED ENVIRONMENT

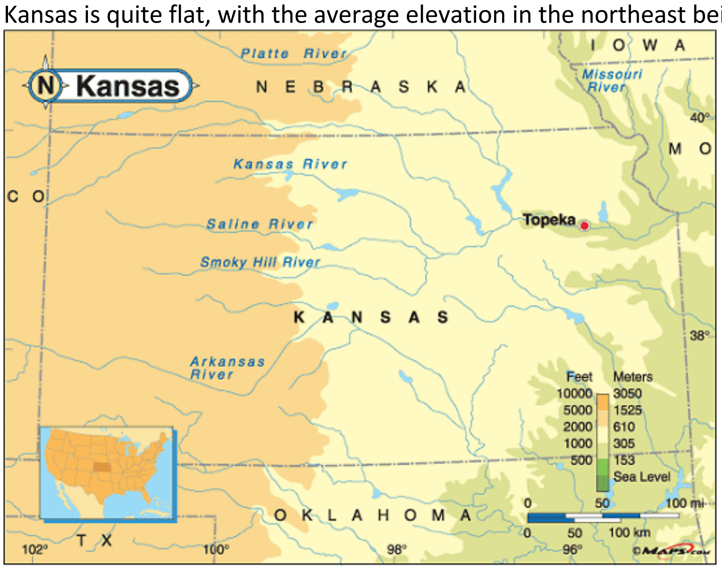
1. AFFECTED AREA

SOILS

Soils in project area are optimal for agriculture so they should hold nutrients and have a moderate infiltration rate. Because much of the land is active farmland, there could be an excess of nutrient runoff, causing downstream water to be polluted.

TOPOGRAPHY

Kansas is quite flat, with the average elevation in the northeast being 1,339'.



2. SHORELINES, ESTUARIES, BEACHES, AND DUNES

There are no shorelines, beaches, dunes, or estuaries within or adjacent to the project site. The subject property is not located within a Coastal Zone Management (CZM) area.

3. WETLANDS

Wetlands are important in watershed for flood mitigation and potential natural filtration of pollutants and nutrients.

4. VEGETATION AND WILDLIFE RESOURCES

PLANT COMMUNITIES

Grasses are also very prevalent here. Vegetation within the project area was characterized by two plant communities; maintained grassland and the forested areas. The top land use categories are pasture/hay, cultivated crops, deciduous forest, developed, open space, developed ow intensity, and grassland/herbaceous.

WILDLIFE

Most of the wildlife within the project corridor is expected to be typical in a rural environment. The project corridor could support habitat for small, locally common mammals, birds, and herptiles.

NATURAL AREAS, PARKS, FORESTS, AND WILDLIFE REFUGES

There are no significant natural areas in the lower Kansas watershed.

5. LAND USE

LAND USE

Land use on properties adjacent to the project corridor and along the floodplain is primarily pasture/hay, covering 36.8% of the area. The next largest, covering 19.8% is cultivated crops (agriculture), followed by deciduous forest with 17.1%. The next two highest percentages of 8.1% and 6.9% are developed, open space and developed, low intensity. These two categories put together are spaces with less than 50% impervious surface.

6. HAZARDOUS OR TOXIC SUBSTANCES

No known hazardous or toxic substances, potential pollutants include runoff from agriculture

7. WATER RESOURCES

The water features within the project corridor are Clinton lake, Strowbridge Reservoir, Douglas lake, Lonestar lake, and Quivira lake. Clinton lake has 29.708 sqKm, and all of the following have less than 1 sqKm.

SURFACE WATER QUALITY

Nutrient runoff from agricultural and potential erosion could affect water quality.

GROUNDWATER RESOURCES

This analysis focuses solely on surface water, but I recognize that groundwater resources are most likely available.

8. WATER SUPPLY AND DISTRIBUTION SYSTEM

WATER SUPPLY

Treatment plants, irrigations lines. Most usage is by agriculture so likely lots of irrigation lines, cities use water from 2 plants: the Clinton Reservoir Treatment Plant, and Wolcott Treatment Plant.

9. WASTEWATER COLLECTION AND TREATMENT FACILITIES

WASTEWATER FACILITIES

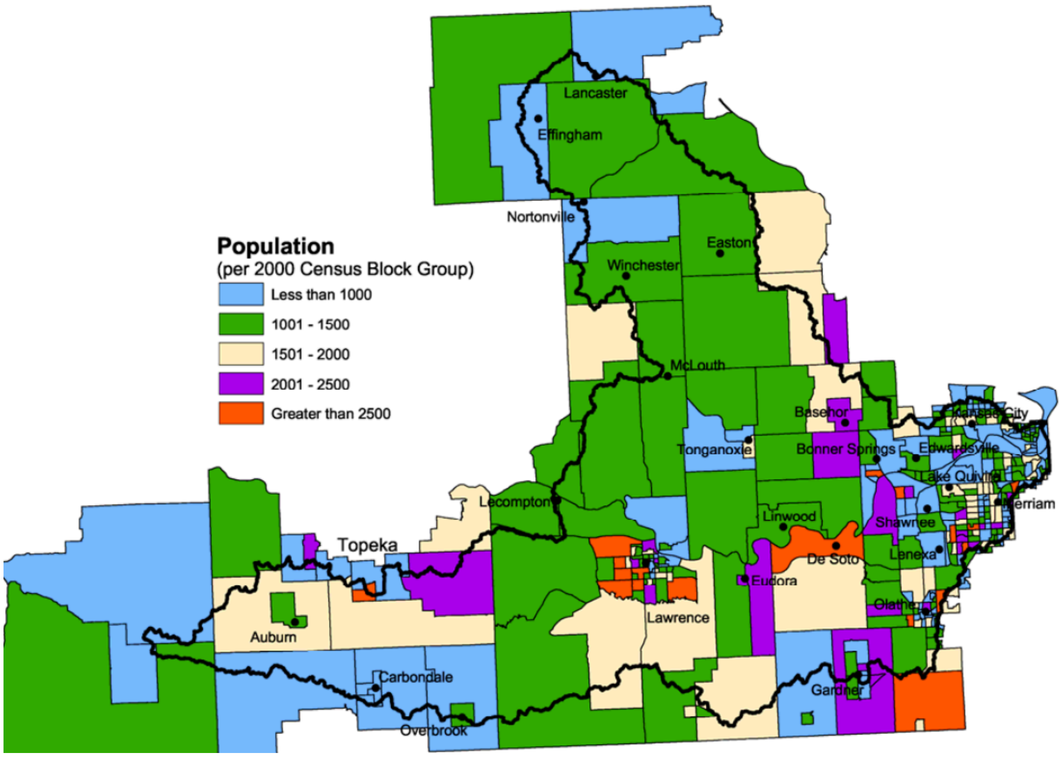
There are three main wastewater treatment plants in the project area: two called Johnson County Wastewater and one called Atchison Wastewater Treatment Plant.

10. ENVIRONMENTAL JUSTICE

POPULATION

This map displays the population distribution in the lower Kansas watershed in 2000. This data is a bit outdated, but since 2000 Johnson County, Douglas County, and Leavenworth all had significant population growth. Wyandotte County on the other hand has seen a drop in population.

Population Distribution Map (2000)



11. TRANSPORTATION

TRANSPORTATION

The project corridor is regionally accessible by several interstate highways, major freeways and a network of arterial roads and local streets. Kansas water is mostly privately owned however, so in order to access water directly, permission is needed.

2. ENVIRONMENTAL IMPACTS OF THE PROPOSED PROJECT

GEOLOGICAL ELEMENTS

DIRECT IMPACTS

Alternative Option 1 and Alternative Option 2

Additionally, based on past land use histories within the immediate areas surrounding the project corridor, soil profiles have been previously disturbed by increasing development and past agricultural uses; thereby, indicating a low probability of pristine soils profiles within the area. Changes in usage through either alternative, would not change the overall topographic relief of the existing landscape, nor impact any one larger-scale geological element.

Best management practices (BMPs) for farmers to protect the water in the project area vary. Furrow dikes can help eliminate runoff from crops, which helps conserve water and also keep nutrients and pollutants from fertilizers out of water sources. Another option is to use herbicide alternatives that have less harmful pollutants, that won't cause problems downstream.

12. HYDROLOGICAL ELEMENTS

MODEL RESULTS

13. SOCIAL AND ECONOMICS CONDITIONS

RECOMMENDATIONS

This water resource analysis will help people see the comparison of rainfall and runoff, and the distribution of the data throughout the area. Farmers can use this to evaluate their location and make decisions to use certain amounts of water for certain things. The public can also make choices regarding conservation and such, and they will also become more aware of the environment around them. This analysis also may raise awareness for possible future projects and action that may need to be taken.

14. LAND USE, LAND USE PLANNING AND CONTROLS

DIRECT IMPACTS

Land use in Kansas is highly skewed towards farmland and such, which uses water whether close to a water source or not. Farming strategies can be improved to reduce runoff so that farmers are utilizing more of the water that runs through their crops. Urban planning can also be more considerate of water flow and how buildings may cause excess runoff for nearby water sources.

3. PROJECT CONCLUSIONS

MODELLING OUTCOMES

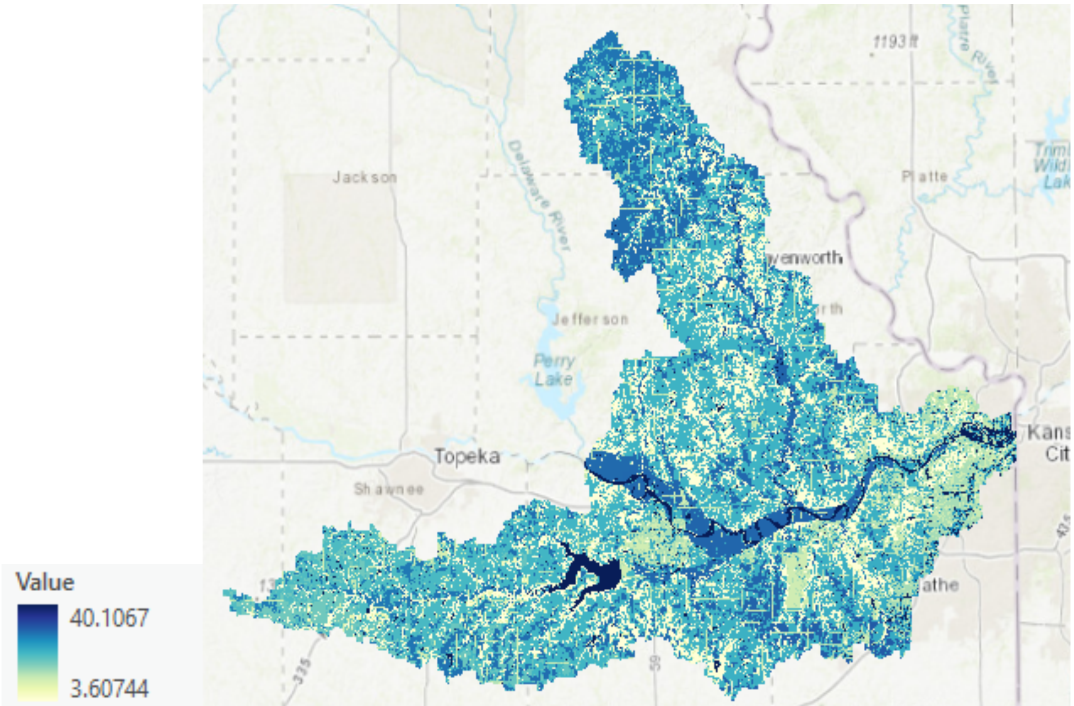
DATA INPUTS

The primary inputs that this project required were elevation data, precipitation data, land use data, and basin boundary lines. For this specific model I used Kansas Elevation data, Mean Rainfall for the United States, Land Use for the United States, and basin boundary lines from Kansas GIS.

METHODS

After downloading all of the data that was required for the model, I had to clip it all down to the basin boundary to make it more manageable. For the land use layer, I had to create a new column in the attribute table for the runoff coefficient. I had to figure out the runoff coefficient for each category of land use in the project area. I also had to change the pixel count to be equal between the rainfall and land use layer. For the actual model itself I would have used the equation Q=ciA (Peak discharge = rational method runoff coefficient * rainfall intensity * drainage area), but I had issues with my elevation data and was in the end unable to obtain the drainage area.

MODEL OUTPUTS/RESULTS



UNCERTAINTY

Lots of the data used in this model was clipped from a far larger extent, meaning the level of detail is probably not ideal.

LIMITATIONS OF MODEL

I found it very difficult to find the data that I needed for this project. Most of the data that I needed existed on KansasGIS but was not public. I was able to find some layers that seemed perfect but didn't cover the whole project area or didn't have adequate attributes for the project. As mentioned earlier, the data may not be as accurate as possible since the layers I was forced to use were clipped from US data or even World data.

CUMULATIVE ASSESSMENT OF THE PROJECT

With this project I was able to show where in the Lower Kansas Watershed there are high versus low amounts of runoff. This helps spark action to reduce runoff in areas that have a disproportionate amount of runoff for the rainfall they receive. Farmers can see how their area is doing and determine what changes can be made to decrease runoff. Construction companies can also look at this to determine where projects should and should not be built based off runoff amounts. They will want to avoid building in floodplains and other areas that may be prone to excess runoff. The general public can look at this project to investigate how they can reduce runoff in more urban and suburban areas.

4. REFERENCES

Dasc. (n.d.). Data Catalog. Retrieved March 22, 2021, from http://www.kansasgis.org/catalog/index.cfm?data_id=1821&show_cat=11

Federal Emergency Management Agency (FEMA). 2009. Flood Insurance Rate Map (FIRM) Panel No. 48439C0055K and 48439C0060K Effective 25 September 2009.

GIS data GUIDE: U.S. data by state. (n.d.). Retrieved March 22, 2021, from https://guides.lib.purdue.edu/c.php?g=353290&p=2378621#Kansas

Kansas Center for Agriculture, Kansas Alligiance for Wetlands and Streams, KState Extension. Watershed Restoration and Protection Strategy. Retrieved March 17, 2021, from https://kswraps.org/wp-content/uploads/2020/10/lowerkansas_plansummary.pdf.

Kansas-Lower Republican Basin Total Maximum Daily Load. Retrieved March 17, 2021, from https://www.kdheks.gov/tmdl/2016/Lower_KS_R_TP_TMDL.pdf

US Department of Agriculture, Kansas Department of Health and Environment. Kansas Rapid Watershed Assessment Lower Kansas Watershed. Retrieved March 17, 2021, from https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_032337.pdf

US Department of Commerce, N. (n.d.). About the precipitation analysis pages. Retrieved March 22, 2021, from https://water.weather.gov/precip/about.php

USGS water Resources links for: 10270104 - LOWER KANSAS. (n.d.). Retrieved March 17, 2021, from https://water.usgs.gov/lookup/getwatershed?10270104

Water related links. (n.d.). Retrieved March 17, 2021, from https://kwo.ks.gov/about-the-kwo/our-partners

Watersheds and river basins. (n.d.). Retrieved March 22, 2021, from https://geokansas.ku.edu/watersheds-and-river-