Andrew Martin
Professor Day
GEOS 571-50
29 April 2022

Flood Mapping Clay City

Clay City is a small, rural town in Eastern Kentucky that frequently deals with flooding. Red River runs through the middle of Clay City and loops around the more populated, downtown area. This frequent flooding often results in property damage to the people in this town. Currently there is no flood prevention in place to protect the people of Clay City from flooding events. In this paper I will discuss my method of flood mapping Clay City, address the area impacted by each flood stage, and propose solutions for their flooding.

I began my flood map of Clay City by gathering data from 5 different sources: USGS National Water Information System for stream gage data, NOAA NWS Advanced Hydrologic Prediction Service for flood stage data, USGS 1 Arc Second DEM for elevation data, USDA-FSA-APFO NAIP Imagery for satellite imagery, and US Census TIGER/Line Shapefile for the boundary of Clay City. I began mapping my data by setting the coordinate system as NAD 1983 State Plane Kentucky FIPS (Meters) and adding my USGS 1 Arc Second DEM elevation data and my TIGER/Line shapefile boundaries. For my boundary I used select by attribute to select county name equal to Powell and subcounty name equal to Clay City. I right clicked on my shapefile layer and made a new layer from selected feature. I used the Project tool to project my new boundary layer to the current map projection.

When using a 1 Arc Second DEM there was a small portion of the west side of the city that wasn't included by just one DEM so I needed to add the 1 Arc Second DEM that covers the west side. To calculate my flood stages I needed my elevation data as one cohesive raster instead of 2 separate rasters. To fix this I used the Mosaic Raster tool and made then into one elevation raster. I used the extract by mask tool to extract the elevation raster to the extent of the Clay City shapefile.

I added USDA-FSA-APFO NAIP Imagery for satellite imagery which consisted of 12 separate 3.75x3.75 minute images that create a background for my flood map. I need to calculate my corrected gage and flood category elevation in meters (*see Table 1*) before I could begin mapping them. I found my datum conversion amount of 0.161 and used that to find my corrected gage elevation by multiplying my gage elevation (600.47 ft) by the conversion to meters (0.305), then adding my datum conversion (0.161). This resulted in a corrected gage elevation of 183.304 m. I converted the flood category depth from the NOAA NWS Advanced Hydrologic Prediction Service from feet to meters, then added the corrected gage elevation and the flood category depth in meters to find the correct flood category elevation in meters for each flood category.

Table 1. Gauge and flood elevation conversions

Flood Category Stage	Flood Category Depth (ft)	Flood Category Depth (m)	Corrected Flood Category Elevation (m)
Action	13	3.965	187.27
Flood	17	5.185	188.49
Moderate	19	5.795	189.10
Major	23	7.015	190.32
12/09/1978	26.75	8.15875	191.46

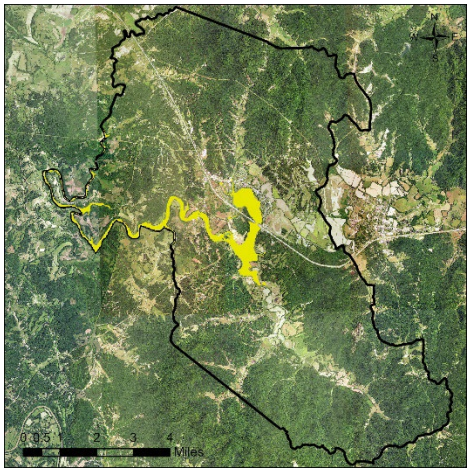
Now equipped with the correct flood category elevation I could begin mapping each flood category in ArcGIS Pro. I used the Raster Calculator tool to calculate the

areas in the Clay City elevation raster with an elevation less than or equal to the corrected flood category elevation of each stage. After calculating each category I made the non-flooded areas transparent and gave each category a unique color for the flooded areas. Using the attribute table for the newly calculated layers I recorded the non-flooded and flooded cell counts for each stage. I divided the flooded cell count by the total number of cells in Clay City (229,993) to see what percent of Clay City was flooded in each stage (*see Table 2*).

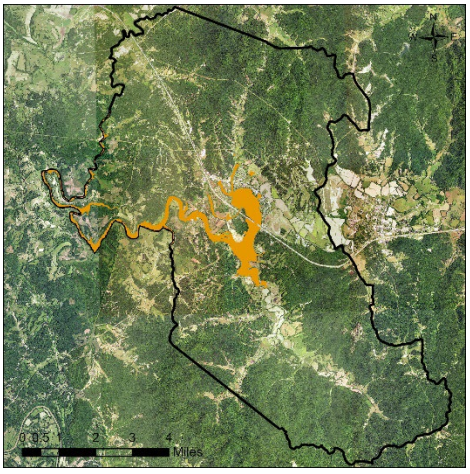
Table 2. Flood impacts in Clay City.

Flood Category Stage	Non-Flooded (0) Cell Count	Flooded (1) Cell Count	% Clay City Flooded Flood Stage
Action	223235	6758	2.94%
Flood	221599	8394	3.65%
Moderate	216681	13312	5.79%
Major	213693	16300	7.09%
12/09/1978	211415	18578	8.08%

Action Stage



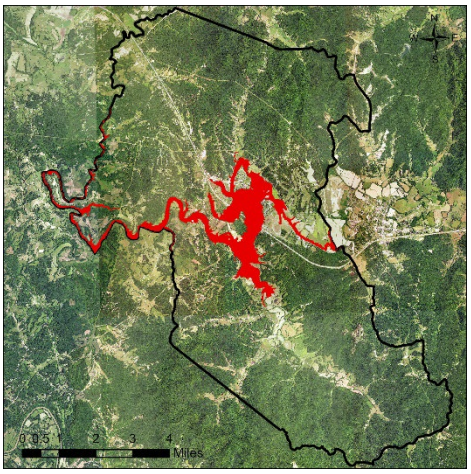
Flood Stage



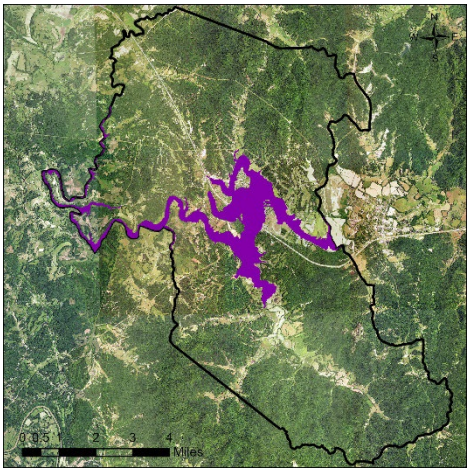
In the action and flood stages we see flooding in the central and western parts of Clay City. In these first 2 stages less than 5% of Clay City is flooded, but largest amount of flooding is occurring in the central part where the more populated downtown area

lies. In action stage very few people are impacted but in the flood stage we begin to see more homes and buildings begin to see flooding.

Moderate Stage

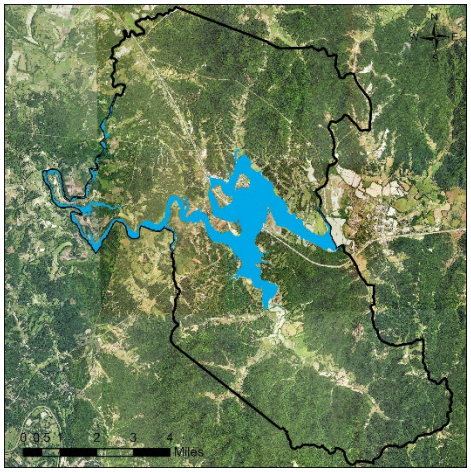


Major Stage



In the moderate and major stages we see more flooding in the central and west parts of Clay City and flooding in the eastern part of Clay City where we didn't see any flooding in the first 2 stages. More than 5% of Clay City is flooded in these stages. Looking at the central, downtown area of Clay City you can see lots of property is flooded in the moderate stage. In the major stage majority of the property located in the downtown area is flooded.

Historic Crest (12/09/1978)



Historic Crest (03/01/2021)

The highest flood experienced by Clay City was on 12/9/1978. On that day, Red River flooded 26.75 feet. There was a forced evacuation of about 300 of the 1500 residents. The image above on the right was taken during a flood on 3/1/2021. Red River flooded 25.76 feet making it the 2nd highest flood in Clay City. The image shows just how large of an area is impacted and how high the water gets during major flooding events.

Flood prevention for Clay City is difficult due to multiple factors: population, and cost, and location. Clay City is a small town with a population less than 1500 people. Due to the it's small population there isn't much attention being brought to the area about this issue for any major flood prevention to be implemented. Major flood prevention methods are expensive and with Clay City being a small, rural town it lacks the funding on the city and county level and would be overlooked for funding on the state level. The last reason why flood prevention would be difficult for Clay City is it's location along Red River and the areas the receive the most amount of flooding. Due to the bend in the Red River in the center of the county, and the location of their downtown area being within that bend, that area receives a large amount of the flooding especially in the moderate and major stages.

The best method of flood prevention in Clay City would be to have warnings in place for residents before flooding occurs. In the chance of a flooding at the major stage occurring there should be warnings instructing residents to evacuate. The houses and buildings in the flood prone areas should be built without basements. Ideally the home closest to Red River should be on some level of piling. Any businesses with hazardous

chemicals, such as gas stations, should ensure that they are using proper methods of storage to ensure they don't introduce any chemicals into flood water.

I was able to answer my research objective in my flood mapping but if I could make any additions or channges to my flood mapping I would add a layer to my map consisting of all addresses in Clay City to assess the percent of houses and buildings impacted by flooding in each stage. Since the areas with the highest population density receive some of the most flooding, the total percent of Clay City doesn't tell what percent of Clay City homes and buildings are impacted by flooding. In the 1978 historic flood 8.08% of Clay City was flooded, but 20% of residents were forced to evacuate. I believe this would give an alternative and possibly more accurate perspective of the impact of each flood stage has on the residents of Clay City.

Works Cited

Childers, Ben. "Clay City in Powell County." *National Weather Service*, 2021, https://www.weather.gov/jkl/022821_Flood. Accessed Apr. 2022.

"FSA 10:1 NAIP Imagery m_3708301_se_17_h_20160522_20160913 3.75 x 3.75 Minute." *ScienceBase*, Apr. 2022, https://www.sciencebase.gov/catalog/item/59eb303de4b0026a55feb6bf.

"Tiger/Line Shapefiles." *Census.gov*, Apr. 2022, https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html.

US Department of Commerce, NOAA. "National Weather Service Advanced Hydrologic Prediction Service." *Advanced Hydrologic Prediction Service*, Apr. 2022, https://water.weather.gov/ahps2/hydrograph.php?wfo=jkl&gage=cyck2.

"USGS 1 Arc Second n38w084 20220311." *ScienceBase*, Apr. 2022, https://www.sciencebase.gov/catalog/item/622c3711d34ec9f19eea4b09.

"USGS 1 Arc Second n38w085 20220311." *ScienceBase*, Apr. 2022, https://www.sciencebase.gov/catalog/item/622c370fd34ec9f19eea4b07.

“USGS National Water Information System (USGS 03283500 RED RIVER AT CLAY CITY, KY).” *USGS Water Data for the Nation*, Apr. 2022, https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=03283500.