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Analysis Of Land Use In Rockbridge County, VA From Pre-Colonial Times To Current Day And Consequences For Riparian Ecosystems

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ANALYSIS OF LAND USE IN ROCKBRIDGE COUNTY, VA FROM PRE-COLONIAL TIMES TO CURRENT DAY AND CONSEQUENCES FOR RIPARIAN ECOSYSTEMS



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INTRODUCTION

Emplacement of dams caused a decrease in stream velocity which allowed suspended sediments to settle out behind the dam structures. These sediments, hereby called legacy sediments, can hold a record of changes in land use activities such as agriculture, timbering, and development that have replaced indigenous stewardship (Walter and Merritts, 2008). The goal of this study is to learn about the land use history of Rockbridge County, Va and how this land use has affected the waterways, in particular the Maury River, over time.



The study area is located in the James and Maury River watersheds. Geologically, Rockbridge County is located in the Valley and Ridge geomorphic province of Virginia. Bedrock in the region is primarily composed of limestone, calcareous shale, and dolomite; however, there are some small traces of sandstone and conglomerates in the region as well but not common (Wilkes, 2007). Four dam sites were sampled from Rockbridge County, VA along the Maury River. This study attempts to answer how dam emplacement and/or removal, as well as taking into account other forms of land use, and

Figure 1: Collection of photos from in the field and from lab prep of samples for carbon dating.

how this has affected the Maury over time.

This study is based off of 1 month of field research (Figure 1) and uses maps and other historical data to construct GIS visualizations of past and present land use, and create estimates of floodplain and water levels during the various intervals of history in the watershed. Age dating of sediment was attempted to create a more accurate time scale of what is being seen in the banks than what is currently determined by assumption from dates known from implementation and removal of dams.

METHODS

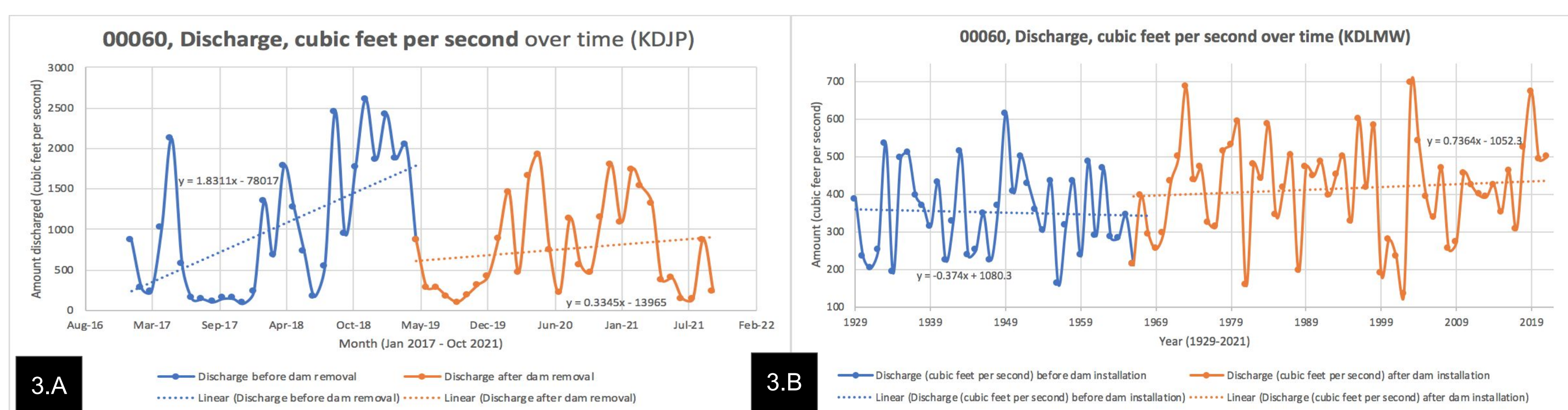
- Sediment samples were collected every 5-10 cm at vertical banks upstream from removed dams.
- X-Ray Diffraction (XRD) was used to determine dominant lithology of the sediment collected.
- Radiocarbon (C14) dating of sediments was attempted to create a more precise timeline of changes as recorded by bank sediments.
- ArcGIS software was used to create maps at various points in history to construct a visual timeline of events and evolution of land use in the region over time.
 - Usage of historical maps, aerial photos, lidar data, census data and other historic documents.
- 2D models were made from topographic maps to compare water levels by creating DEMs from the topographic maps and LiDAR data available, and then highlighting the various elevations in the county.
 - 3D models were made from a conversion of this.
- Discharge data was collected from the USGS water data online mapper then imported into Excel to create graphs depicting change in discharge downstream of two dam sites.

DISCHARGE, WATER CAPACITY, & FLOODING

The discharge data downstream of Lake Merryweather was examined on a yearly scale from 1929 to the present day. The graph shows that after dam installation, the slope of the discharge increases from before the dam was installed. This is an indication that the dam is creating more discharge than would be occurring naturally. It is worthy to note that this dam is dredged every so often.

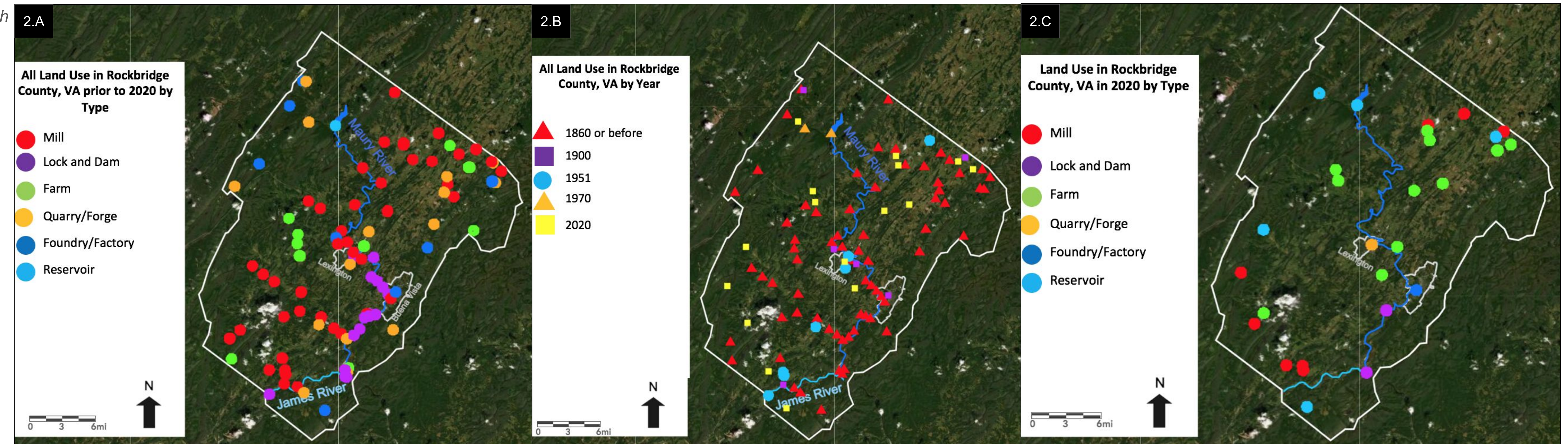
The discharge data from downstream of Jordan's Point was looked at from a monthly scale for two years prior and two year following the removal of the dam. The graph shows that the slope decreases after dam removal compared to when the dam was in place. This is an indication that the dam was causing more discharge over time than what would have occurred naturally. The system appears to still be changing and it would be of interest to examine how this changes further in the future. Historic flood data for this location is shown in Table 1.

A 3D model (Figure 4) as created to visualize the water elevation in the region. This was used to compare the volume of water in the Maury River to discharge levels.



LAND USE AND LAND USE HISTORY (Cont.)

Figure 2: Created with ArcGIS Online. A. Land use in Rockbridge County, VA prior to 2020 organized by type. B. Land use in Rockbridge County, VA organized by installation year. C. Land use in Rockbridge County, VA as of 2020.



Virginia implemented one of the earliest programs of infrastructure improvements called The Fund for Internal Improvement, designed to improve commerce after the American Revolution in 1816. The program was implemented in response to a sense of urgency within the state to share in the wealth of the new country. Virginia implemented improvements to its extensive river system that facilitated these commercial needs (McKee, 2003). By 1860 there were approximately ten navigation dam structures and at least thirty mill dam structures operating along waterways in Rockbridge County, VA (Rockbridge Co., Va. [186]). A series of maps (Figure 2) was created to show how land use in the county has changed over time.

During the study timeframe, approximately forty-five mill dams, fifteen lock dams, and four reservoir dams, totaling sixty-four dams, have operated in the county. Not enough data was available from pre-colonial and early colonial times to put together a map for these times. There were dams created and operated during pre-colonial or early colonial times. One of the sampled dams, McCormick's Mill Dam, was created before 1760 but no exact date is known. There are other dams that have recorded dates predating our study timeframe. These include Pagues (Red) Mill (1765-present), Beatty's Mill (1750-?), and Hay's Creek Mill (1760-1957). There are likely others that fall in this category, but specifics for many of these old dams are unknown. The first reservoir dam was the dam at Lake Merriweather which was created for recreation purposes in 1966 (McKee, 2003 and U.S. Department of the Interior).

Approximately seventeen furnaces/foundries and twenty-three iron mines/quarries have operated in the county. (Rockbridge Co., Va. [186], U.S. Department of the Interior, and Rockbridge County, Va.) There were also six furnace's that operated in the region prior to our study timeframe: Bath Iron Works (1820-1860), Jordan Furnace (1800-1860), McCormick Furnace (1834-1854), Moore's Furnace (1849-1853), Mount Hope (1849-1853), and Vesuvius Furnace (1828-1854). Operation dates for Grant's Furnace, McCowen Iron Works, and Lebanon Forge are unknown and unlisted on the maps created (Scott, 2015).

Approximately twenty farms that operated/are operating in the county have been accounted for but we know that there are more (Rockbridge Co., Va. [186]). Locations of many farms found in census records were difficult to find due to lack of old property records and have not been marked on the maps.

RADIOCARBON DATING

Radiocarbon (C14) dating of sediments was attempted to create a more precise timeline of changes as recorded by bank sediments. Previously, the assumed timeline was derived from dates known from dam installation and the present day. I analyzed sediment smear slides from bank sites associated with removed dams to determine which intervals would most likely hold organic material suitable for Radiocarbon dating. Sample isolation for radiocarbon dating was attempted on three of the sites by separation of charcoal and plant using wet-sieving methods. Sieves were placed coarser (300 micron) on top of the finer (180 micron). The samples were put into top mesh and sprayed with deionized water until it disaggregated, letting all the fines pass through and leaving all the coarse material, including plant macros, behind. The sieve contents were transferred to a small petri dish, placed under a picking scope, and a tiny paint brush was used to pick out the plant material. The plant fragments were placed into a small glass, sealable container with two drops of HCl (Krishnaswamy, 1971 and Niemitz, 2013).

CONCLUSIONS & FUTURE WORK

The timelapse maps regarding land use changes shows that the majority of improvements to the county occurred between the Revolutionary War and the Civil War. Progression of land use slowed down after the Civil War. Information regarding land use in the region available after the 1900's was difficult to acquire and the maps during this time period reflect this.

Discharge data and the 2D and 3D models determine that when water levels are high discharge is also high and when water levels are low discharge is also low. The emplacement of dams causes a decrease in stream velocity allowing legacy sediments to settle out behind the dam structures.

C14 dates were not able to be gathered due to concerns of potential contamination from lab prep. Future work for this study may include re-attempting this process and re-submitting for C14 dates, or alternatively Pb dates.

ACKNOWLEDGEMENTS

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Field work was conducted within the traditional territory of the Yesa People (with descendants including the Monacans) & of the Manahoac People, the indigenous stewards of this land.

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Figure 3: Created with Microsoft Excel. A. Monthly discharge data downstream of Jordan's Point Dam graphed with trendline. B. Yearly discharge data downstream of Lake Merriweather Dam graphed with trendline.

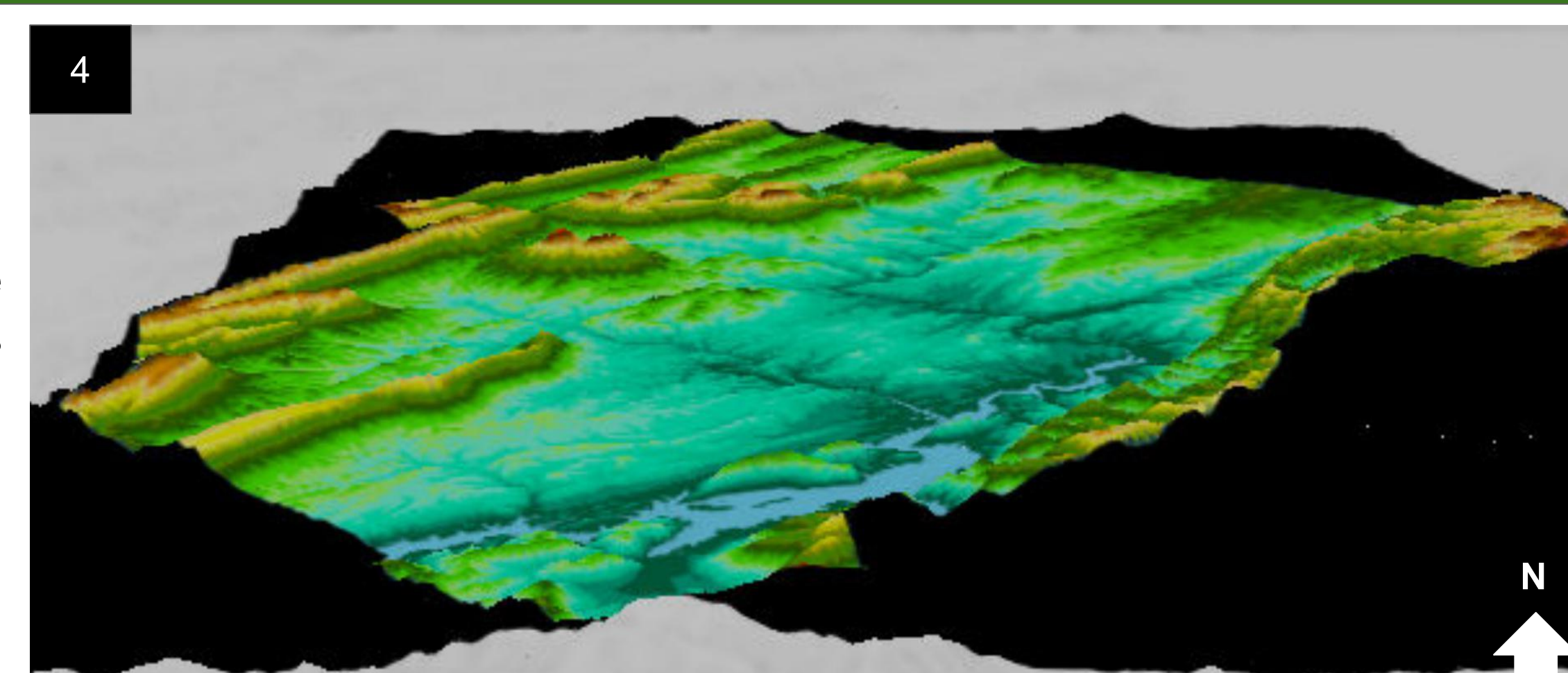


Figure 4: Created with ArcGIS Pro. 3D model of Rockbridge County, VA showing water levels in the region current day.

Flood Date	3/18/36	8/20/69	6/21/72	11/5/85	4/22/92	6/23/95	6/28/95	1/19/96	9/7/96
Discharge	-9,999	105,000	27,800	72,100	35,100	31,900	37,500	32,900	35,300
Type	Major, C1	Minor, none	Major, none	Minor, none	Minor, none	Minor, none	Minor, none	Minor, none	Minor, none

Table 1: Historic flood data for downstream of Jordan's Point Dam prior to 2000. Most noteworthy floods have been minor, with two major floods in the last 100 years.