

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

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INTRODUCTION

In 1816 Virginia implemented one of the earliest programs of infrastructure improvements, called The Fund for Internal Improvement, designed to enhance commerce after the American Revolution. 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, which 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]).

Emplacement of dams caused a decrease in stream velocity, which allowed suspended sediments to settle behind the dam structures. These sediments, hereafter called legacy sediments, can hold a record of changes in land use such as agriculture, timbering, and development that have replaced indigneous stewardship (Walter and Merritts, 2008). The goal of this study is to learn how dam emplacement or removal and land use in Rockbridge County, Va 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 province of Virginia. Bedrock in the region is primarily composed of limestone, calcareous shale, and dolomite; however, there are some exposures of sandstone and conglomerate in the region as well (Wilkes, 2007). Four dam sites were sampled from

Rockbridge County, VA along the Maury River. This study 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 sampled in river banks was attempted to create a more accurate timeline of watershed history.

METHODS

During summer 2021, sediment and water samples were collected from eight dam sites in Rockbridge County, VA (Figure 1). After sample collection, laboratory analyses were completed to create a historical record of environmental changes from pre-colonial times to present day and to identify potential water contaminants. These samples are being examined by me and four other colleagues from various universities and colleges as part of the Keck Geology Consortium 2021 Advanced Project. Samples were taken from the banks of removed dams for geochemical analysis and to establish sedimentation rates. Samples were collected every 5-10 cm from near-vertical outcrops. Organic material was isolated from the bank sediments collected using the Center for Mass Spectrometry's standard operating procedures with the intent to radiocarbon (C14) date the sediments collected, but could not be radiocarbon dated due to concerns of potential contamination from lab procedures. Future work for this study will involve re-sampling to construct an age model using Pb-210.

My study was focused on identifying potential pollution sources for the Maury River watershed from historical data sets. ArcGIS software was used to

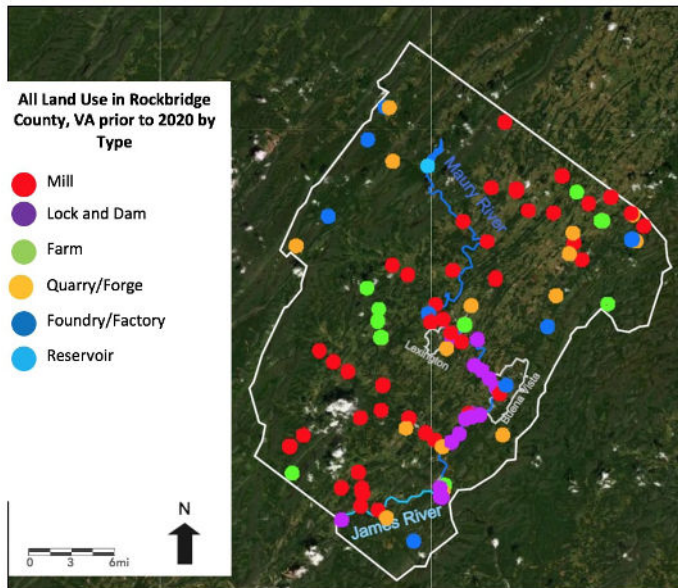


Figure 1. Land use in Rockbridge County, VA prior to 2020 organized by type.

create maps at various points in history to construct a visual timeline of events and evolution of land use in the region over time. Data for these maps was collected using historical maps, aerial photos, LiDAR data, census data and other historic documents. Maps and photos were converted into .tiff files and georeferenced onto the base layer. Data from these files was then highlighted using polygon, line, and point feature classes.

2D models were made to compare water levels in 1964, 1977, and 2018 to compare topography from the beginning, middle, and end of the study timeframe. These years were selected based on available topographic maps and to show changes in the landscape through time. The modeling was done by creating DEMs from the available topographic maps and LiDAR data, and then highlighting the various elevations in the county with different colorations. 3D models of areas downstream of Jordan's Point and Lake Merriweather were made by taking the 2D map and converting it to a local scene, exaggerating the elevation by 2.00 to give depth to the map, and zooming into the sites of interest.

Discharge data for areas downstream of these two dam sites was accessed from the USGS Water Data Online Mapper (USGS, 02024000 and USGS 02021500). The data was then imported to Excel to create graphs depicting change in discharge downstream of two dam sites: one showing before and after dam emplacement

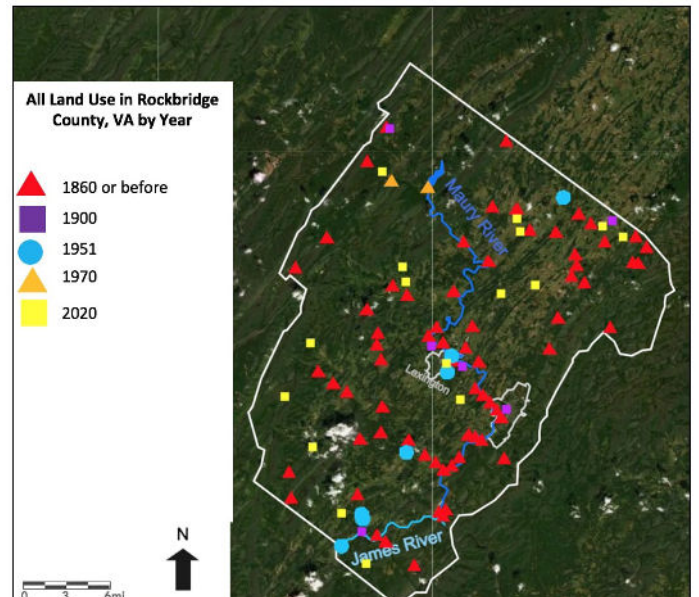


Figure 2. All land use in Rockbridge County, VA categorized by year.

(Lake Merriweather) and one showing before and after dam removal (Jordan's Point).

RESULTS AND FUTURE WORK

The Fund for Internal Improvement allowed Virginia to implement improvements to its extensive river system to facilitate its commercial needs (McKee, 2003). Figures 1 and 2 illustrate how land use in the region has changed since the implementation of the internal improvement through 1970. Figure 3 depicts current day land use as of 2020.

During the study timeframe, a total of at least sixty-four dams, including approximately forty-five mill dams, fifteen lock dams, and four reservoir dams, have operated in the county. Approximately seventeen furnaces/foundries and twenty-three iron mines/quarries have operated in the county. Approximately twenty farms that operated/are operating in the county have been accounted for, but this number is certainly an undercount. Locations of farms found in census records were difficult to find due to lack of old property records, and have not been marked on the maps (Rockbridge Co., Va. [186], U.S. Department of the Interior, and Rockbridge County, Va.)

There was insufficient data from pre-colonial and early colonial times to put together a map for these periods, but based on the timelapse maps we know most of the European land use practices were put in place before

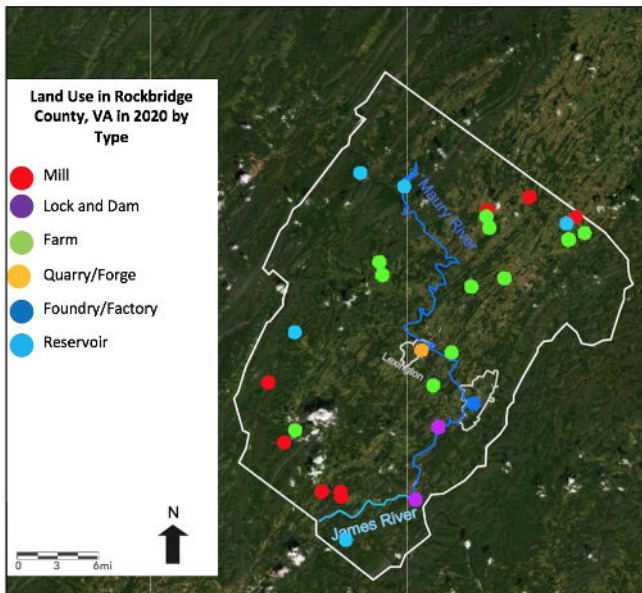


Figure 3. Land use in Rockbridge County, VA in 2020 categorized by type.

the 1860s. We know of some dams that were built and operated during pre-colonial or early colonial times. One of the sampled dams, McCormick's Mill Dam, was created before 1760 but the exact date of construction is unknown. There are other dams that have recorded construction dates predating our study timeframe. These include Pogues (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 modern reservoir dam was the dam at Lake Merriweather, which was created for recreation in 1966 (McKee, 2003 and U.S. Department of the Interior).

There were also six furnaces 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).

The timeline of 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 after the 1900's was difficult to acquire, and the maps

during this time period reflect this. The drop in land use during the 1900's from the 1860's could be in part due to destruction of certain industry operations during the war. Lock and dam structures had almost disappeared by 1950. In the 1970's we started to see land use move away from our major waterways. We also see the first reservoir dam installed during this time. Current day land use is dominated by farms and most land use takes place farther away from our major waterways than what was previous practice. Lock and dam structures are no longer in use. Mining is less common now than it had been in the 1800's to 1900's. Reservoir dams are more popular now, be it for recreation, power, or water supply. Very few mills are still in operation compared to the beginning of the study at which they were at their peak.

The 2D and 3D models (Fig. 4) show that, historically, the Maury had higher water levels in the regions with dams than current day with these dams removed. The Lake Merriweather dam had lower water levels than current day with a dam in place.

The annual discharge data downstream of Lake Merriweather at Rockbridge Baths was examined from 1929 to the present day. The graph (Fig. 5) shows that after dam installation, the range of peak discharge values increases from before the dam was installed. This is an indication that the dam has created a disruption to natural flow conditions. It is worth noting that this dam is "flushed" periodically when sediment infilling behind the dam becomes an issue, which could be partly responsible for some of the discharge peaks seen on the graph after dam installation.

CONCLUSIONS

The maps created for this study show a decrease in land use over time and a shift from operations centered around major waterways such as the James and Maury Rivers to areas that are in contact with minor tributaries to these major waterways. The maps also show a shift in industry from more milling and mining operations in the 1800's to more farming in the present day.

The 2D and 3D models show that the Maury and James river water levels are lower now than they were with the heavy dam intervention during the mid 1800s

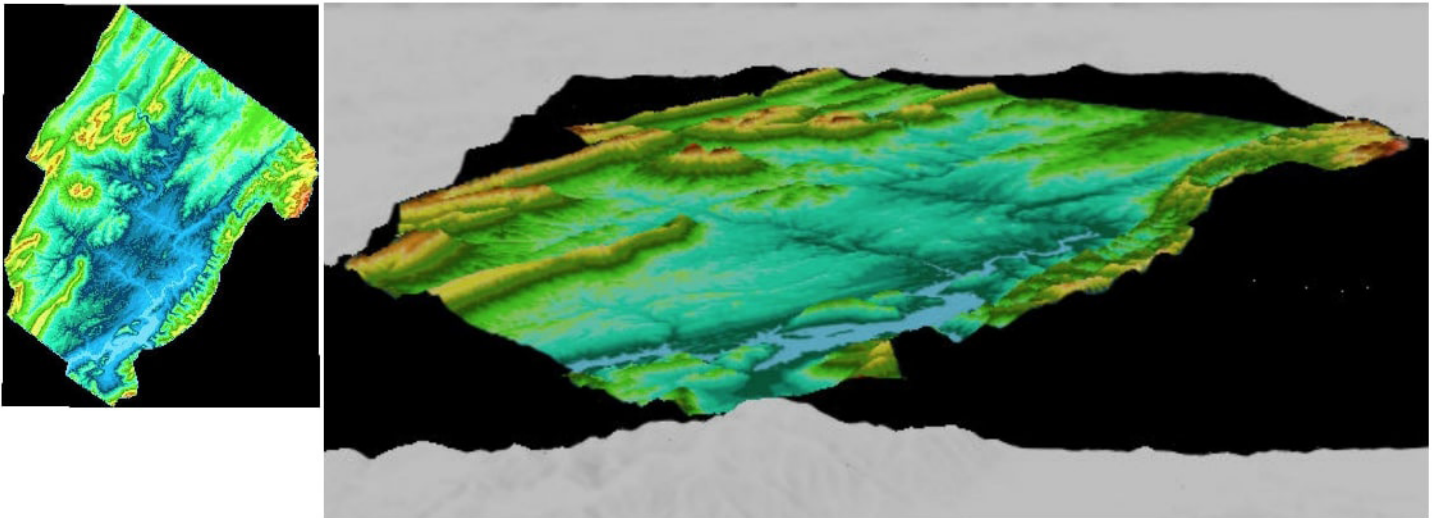


Figure 4. A) 2018 2D rendering of Rockbridge County based on elevation. B) 3D rendering of Rockbridge County based on the 2D model.

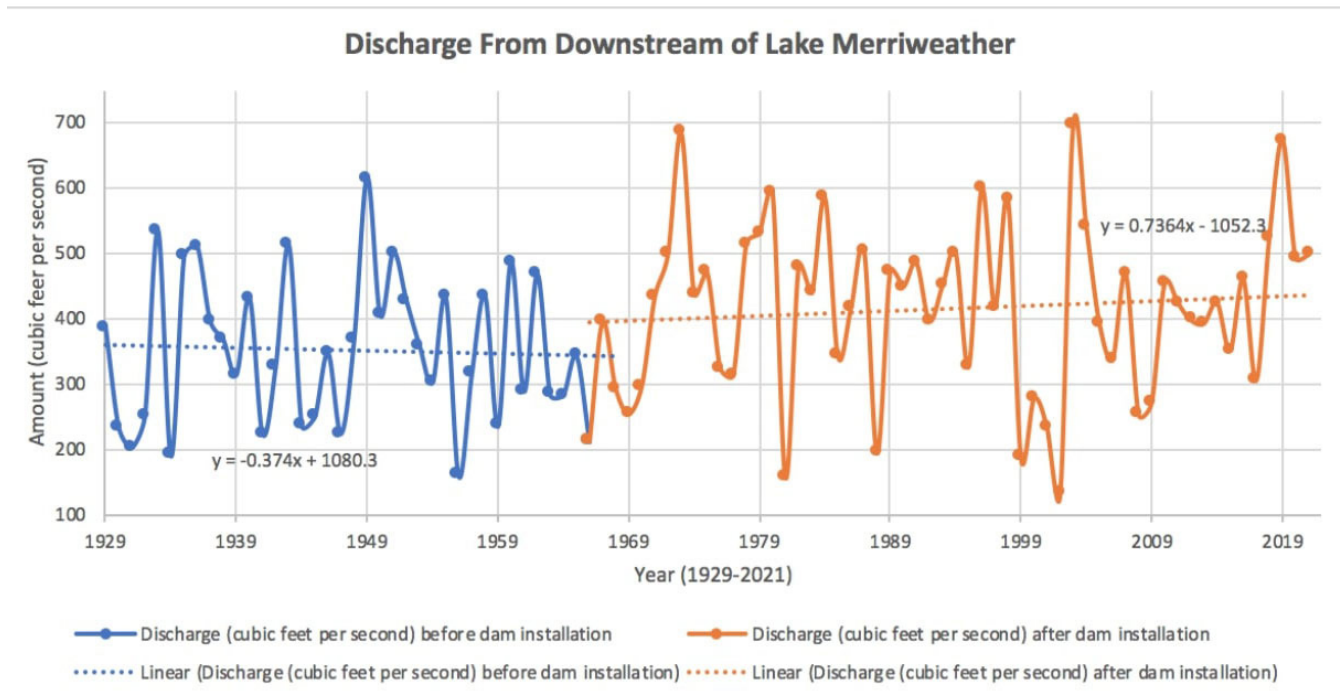


Figure 5. Yearly discharge data downstream of Lake Merriweather Dam graphed with a trendline. Information collected from USGS National Water Information System Mapper. Site: 02021500..

through the 1900s and also lower than in the 1950s.

We are able to determine that high water levels correspond with high discharge, and low water levels correspond with low discharge. The emplacement of dams caused a decrease in stream velocity allowing legacy sediments to settle out behind the dam structures. As the dams are removed, we run the risk of these sediments remobilizing and spreading contaminants throughout the waterways.

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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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