TENESSEE RIVER WATERSHED AND NORRIS DAM AFFECTS

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CONTENTS

Introduction

The Tennessee River and Watershed have a lengthy history. The Tennessee River begins in Knoxville and spans about 652 miles and is actually a tributary of the Ohio River[2]. The first massive dam was built in 1933 on the Clinch River and is known as Norris Dam[1]. Most of the dams were built for flood mitigation and to create electricity. This river is actually home to 42 separate dams today[1]. In recent years, there have been many disputes about the environmental impact of dams. Some of these impacts include reducing flow and eliminating downstream fragments of the river, altering fish spawning habitat, and impacting water quality by allowing the still water to heat up or host algal blooms[3]. Due to these impact, many dams are scheduled to be removed across the country, including the Roaring River Dam in Crossville, Tennessee[4]. This project is in response to these planned projects, flooding potential will be observed for the Norris Dam on the Clinch River tributary off of the Tennessee River. The upstream effects of the dam is where this project will focus.

Objective

This project will look at the hydrological connectivity of the Tennessee River watershed and delineation for the watershed without the dams. The overall watershed will be analyzed for drainage responses, slope, elevation changes, and potential flooding factors. The section of the watershed upstream of the Norris Dam will then be analyzed with and without the dam present. The final results will look at how the Norris Dam is affecting the river and the surrounding area's flooding potential without the interference of the other damns present according to ArcGIS results. This information will also look at the buildings at risk of being impacted by flooding before and after the dam is "removed" from the river.

Site Description

The Norris Dam is located on the Clinch River, a tributary of the Tennessee River. The Norris Dam is just outside of Norris Lake, within Tennessee. This area has high humidity and gets about 26.82" of rain per year. The weather stays between 39 – 80 degrees Fahrenheit on average. The area contains mountains and flat plateaus. The land around Norris dam is relatively flat, with the Great Smokey Mountains nearby to the east. The exact areas will be determined once the GIS map is being developed.

The HUC8 (06010205) which homes the Upper Clinch River and contains Norris Dam spans 5091.27 km2. The area downstream of the dam location lies in HUC12 060102051106 and spans 181.37 km2. This is the area where we will observe the flooding effects of the Upper Clinch without Norris Dam.

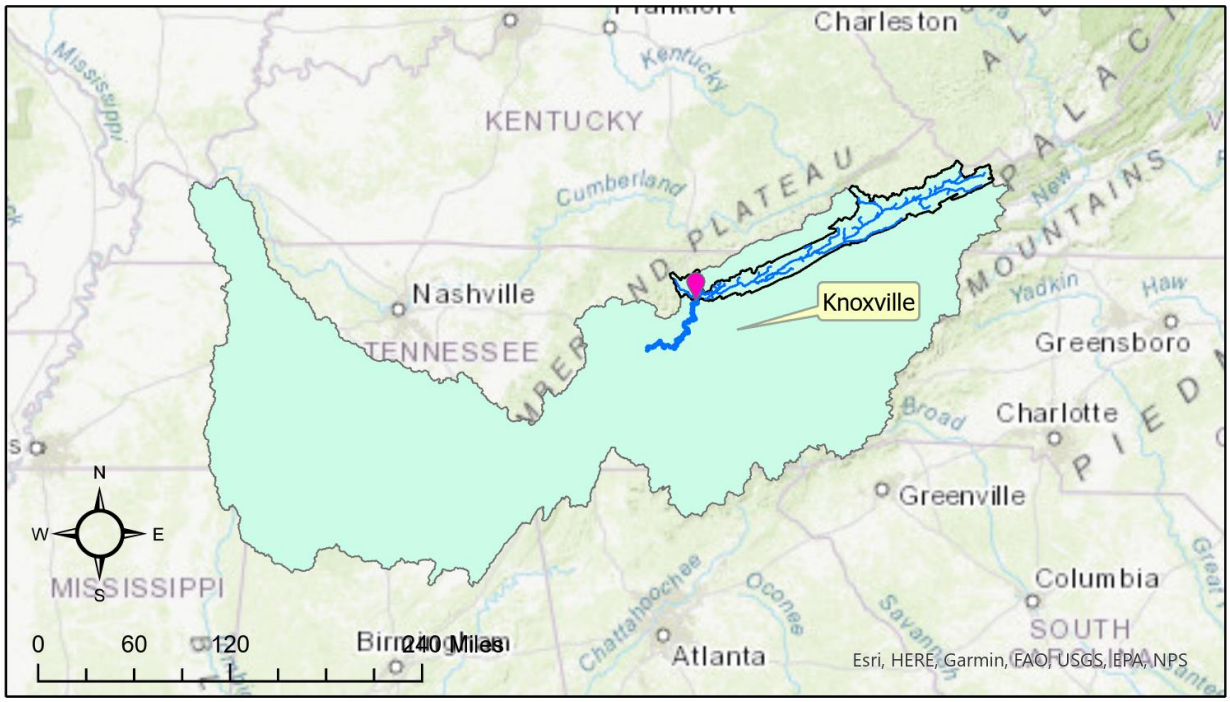


Figure 1: This is the entire Tennessee River Watershed. The red point indicated the location of the Norris Dam and the adjacent HUC 8 outline and flowlines within indicate the HUC 8 of interest (06010205) and the Clinch River and its main tributaries that we will be analyzing.

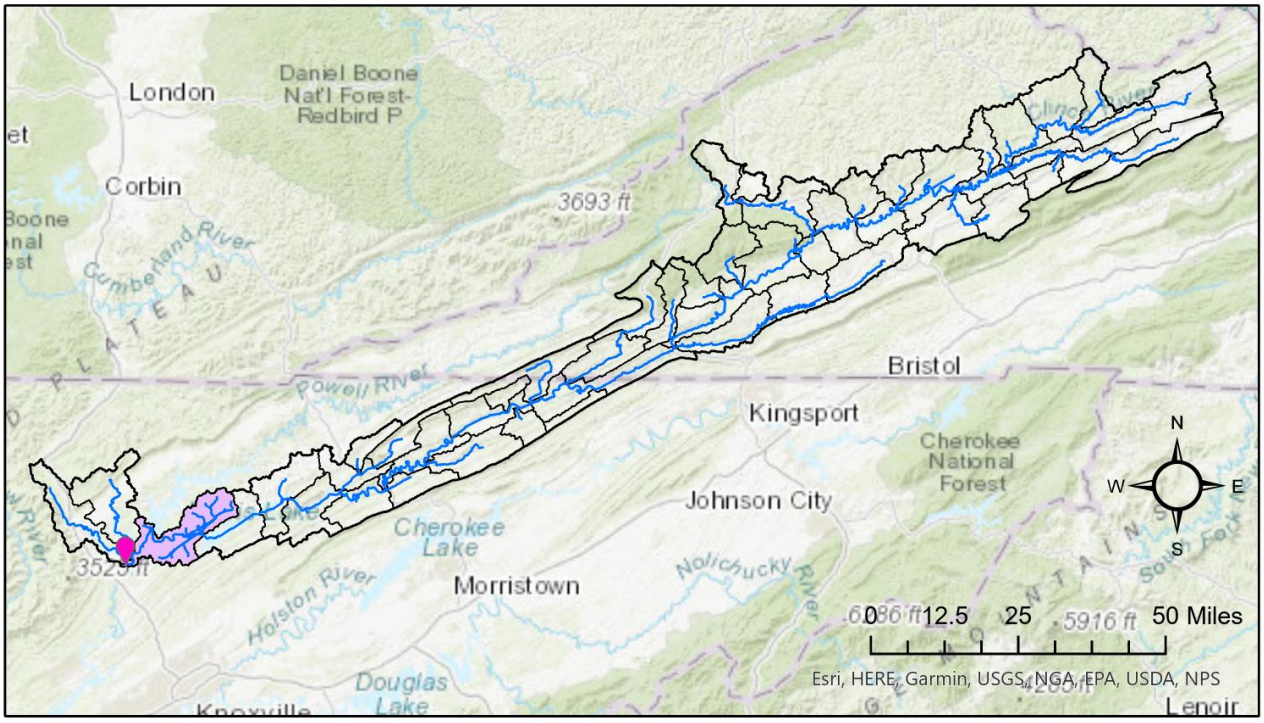


Figure 2: If we take a closer look, we can see the HUC 12(060102051106) that contains the Upper Clinch River (in purple), where we observed the HAND (Height Above Nearest Drainage) for this entire area without dam affects.

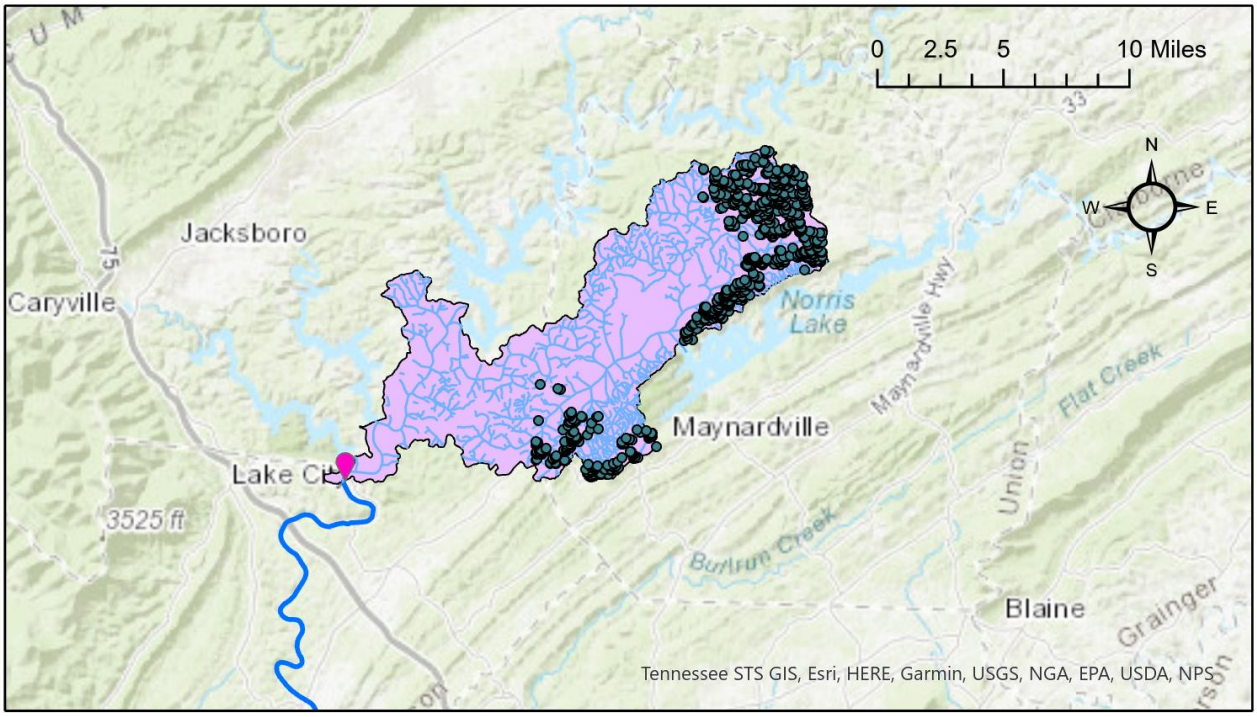


Figure 3: HUC 060102051106 (purple) and associated flowlines will be evaluated using the HAND method with a raster comprised of dam height summed with the original HUC raster. Then, all the address points (green dots) will be evaluated for flood risk.

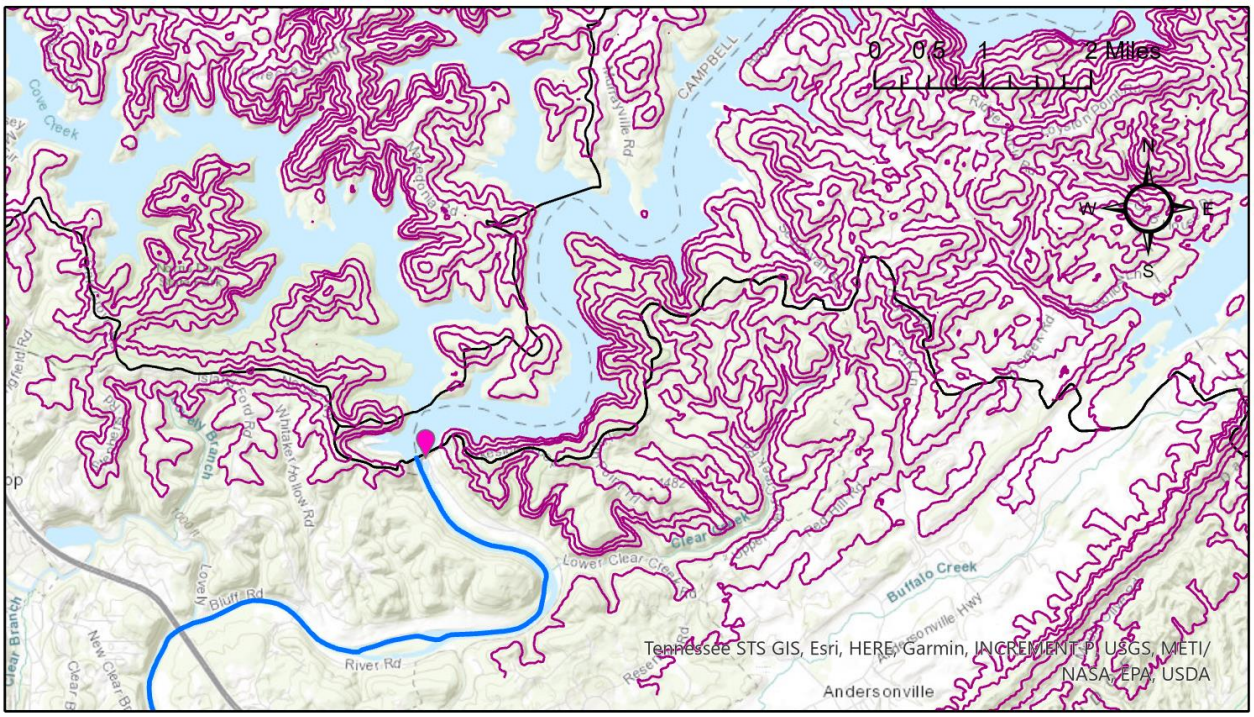


Figure 4: 20 meter contours are shown around the Norris Dam point (in pink) to depict surrounding height change

Data

UPLOADED

Data Name	Description	Vector/Raster	Map Projection	Source	Raster Resolution
Buildings (TNEast_Buildings)	Building locations and areas as polygons	Vector (polygons)	NAD 1983 StatePlane Tennessee FIPS 4100 (US Feet) - Lambert Conformal Conic	GIS Data (tn.gov)	NA
HUC 8, 10, 12	Polygons of HUC8, 10 and 12 basins	Vector (polygons)	NAD 1983	TNM Download v2 (nationalmap.gov)	NA
Flowlines (Lines)	Flowlines for streams within the HUC8 basin of interest	Vector (lines)	NAD 1983 StatePlane Tennessee FIPS 4100 (US Feet) - Lambert Conformal Conic	TNM Download v2 (nationalmap.gov)	NA
Elevation dem 30 m	30 m elevation dem	Raster	North America Albers Equal Area Conic - Albers	Living atlas	X cell: 30.921993824659 Y cell: 30.921993824659

Dam Location	Describes location of the Norris Dam relative to watershed	Vector (points)	WGS 1984	Norris Dam - Wikipedia Excel Table	NA
NHD Area	Area and elevation info for dam with other areas, as well.	Vector (polygons)	NAD 1983	GIS Data (tn.gov)	NA

GIS Methods

REFINING IMPORTED DATA

HUC8 basin of interest (06010205) and HUC12 basin (060102051106) were both downloaded with all the Tennessee Watershed HUC8 and HUC12 and then isolated using the select feature and export data function. This function was used for Tennessee buildings layer after converting building polygons to points, and Tennessee flowlines to narrow the data reach to relevant areas. These steps resulted in data layers HUC8, DwnStrm, Addrpnt, and FlowlineT (HUC8) and streamdwn (HUC12). The polygon layer NHDArea was also downloaded and the Norris Dam feature was selected, and exported to a new polygon feature. The Polygon to Raster function was used using the elevation column of the attribute table to create the Norris Dam raster (norrisdwnstrm). Finally, the Elevation dem 30 m raster from the living Atlas was downloaded to begin our analysis. Map 1 (Appendix B) describes the basin area and land upstream of the Norris Dam before the HAND analysis, the zoomed in map extent shows the location and polygon of the Norris Dam.

HEIGHT ABOVE NEAREST DRAINAGE (HAND)

See Figure 5 on next page for HAND steps used.

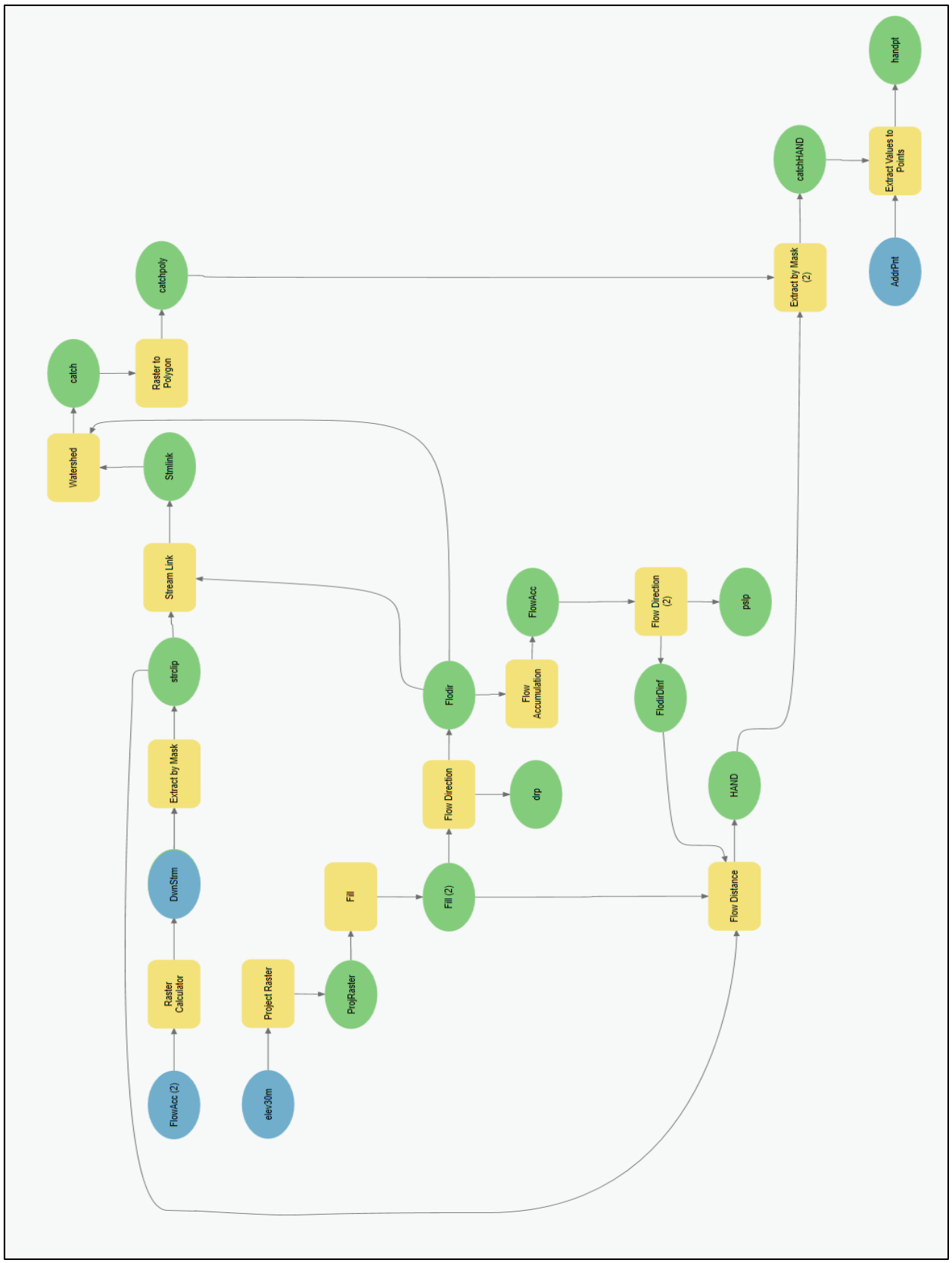


Figure 5: Flow diagram for GIS steps- repeated for sum of basin and dam rasters.

CREATING THE DAM RASTER

The polygon layer NHDArea was also downloaded and the Norris Dam feature was selected, and exported to a new polygon feature. Polygon to Raster function was used using the elevation column of the attribute table to create the Norris Dam raster (norrisdwnstrm). The raster calculator function was then used to sum norrisdwnstrm with dwnstrmrast (raster created from 30m elevation layer for the HUC 12 060102051106 only) to make *sumrastdwnstrm*. All HAND steps above were repeated with this new sum raster.

ADDRESS POINTS WITH POTENTIAL FLOODING

Once the hand points were determined for each scenario (with and without the dam), the address points were selected by attribute. The hand points were selected based on their attribute table results under the RASTERVALU column. This column determined what height each point was above the nearest drainage. It was determined by the frequency of points and quantity of points that any RASTERVALU value under 9 meters would be considered at flooding risk.

Results and Conclusions

Based on the results, it was found that more address points were subject to flooding overall (138 sites) without the dam present. Most of these buildings at risk surround Mill Creek and Norris Lake as seen in Appendix C. In contrast, with Norris Dam present, only 80 sites were subject to flooding. Interestingly, these sites also occurred further upstream from the dam and the lake as seen in Appendix D. This makes sense because when the dam is installed, it will back up some of the water upstream, causing houses that did not previously have flooding risk to be at risk. The HAND rasters are fairly similar when compared, with certain areas of the dammed basin having a lower HAND values. Overall, based on this limited analysis, the installation of the Norris Dam was beneficial and should remain intact.

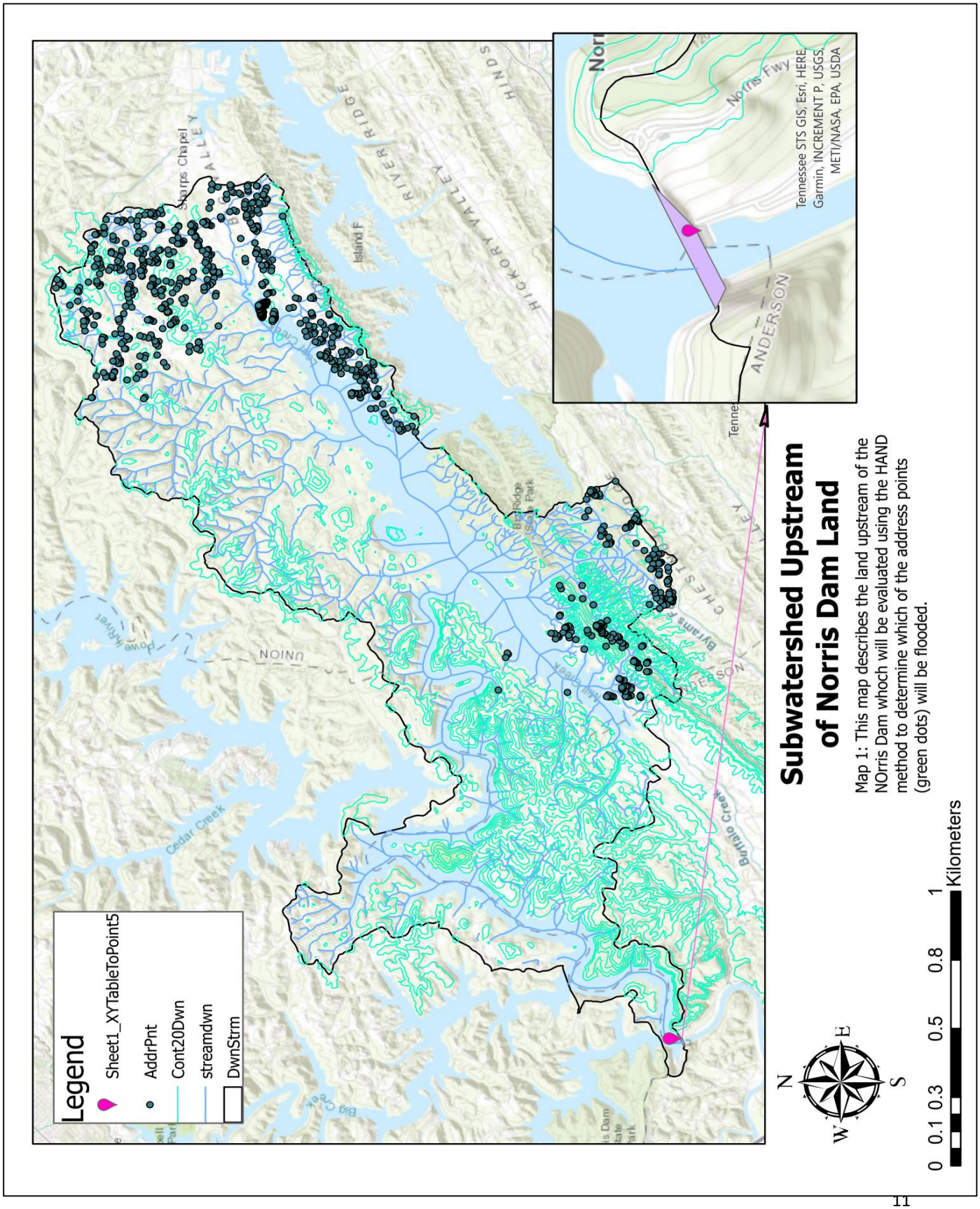
This project included many limitations. Only a small portion of a very large basin was observed. In addition, this analysis was made solely on potential flooding factors. If given more time, the affects downstream of dam would have been observed, as well. The difference in flooding potential between summer and winter would have been helpful data to know too, along with native vegetation, soil and species composition in the area.

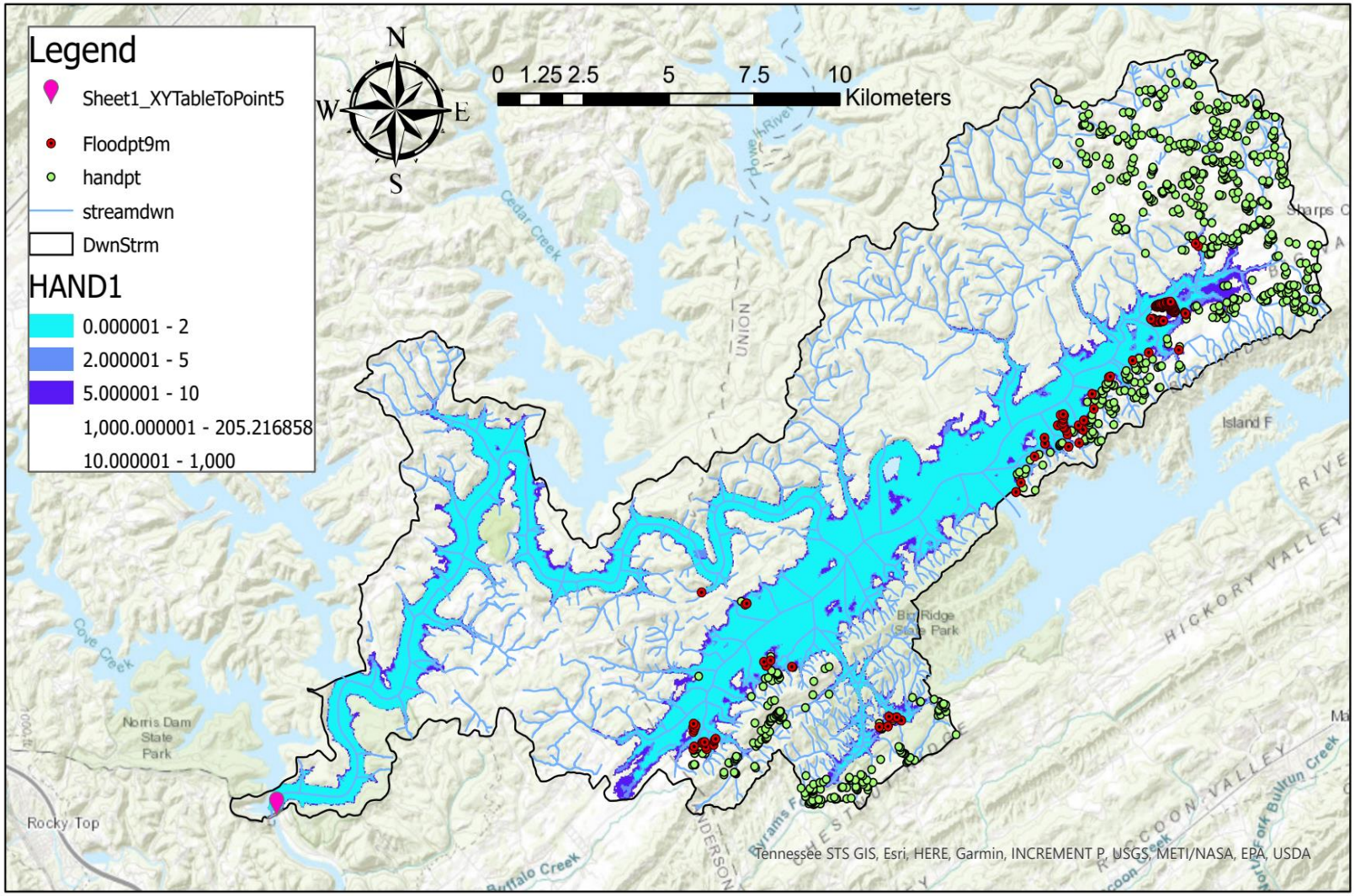
Appendix

APPENDIX A: BIBLIOGRAPHY

1) GIS Data. (n.d.). Retrieved March 12, 2021, from Www.tn.gov website: https://www.tn.gov/finance/sts-gis/gis/data/
2) How dams damage rivers. (2016, February 3). Retrieved March 12, 2021, from Americanrivers.org website: https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/how-dams-damage-rivers/
3) Tennessee RIVERKEEPER. (n.d.). Retrieved March 12, 2021, from Tennesseeriver.org website: https://www.tennesseeriver.org/riverhistory.html
4) TNM Download v2. (n.d.). Retrieved March 12, 2021, from Nationalmap.gov website: https://apps.nationalmap.gov/downloader/#/
5) Wikipedia contributors. (2021a, January 16). Norris Dam. Retrieved March 12, 2021, from Wikipedia, The Free Encyclopedia website: https://en.wikipedia.org/w/index.php?title=Norris_Dam&oldid=1000645593
6) Wikipedia contributors. (2021b, February 7). Tennessee River. Retrieved March 12, 2021, from Wikipedia, The Free Encyclopedia website: https://en.wikipedia.org/w/index.php?title=Tennessee_River&oldid=1005481826
7) (N.d.-a). Retrieved March 12, 2021, from Newschannel9.com website: https://newschannel9.com/sports/outdoors/huge-dam-to-be-removed-on-roaring-river#:~:text=The%20aging%20dam%20on%20the%20Roaring%20River%20in,the%20lake%20formed%20by%20the%20Cordell%20Hull%20Dam
8) (N.d.-b). Retrieved March 12, 2021, from http://5https://www.renewablesfirst.co.uk/hydropower/hydropower-learning-centre/what-makes-a-good-hydro-site/

APPENDIX B – MAP 1





No Dam Flooding Potential

Created by Jessica Erben

Map 2: This map shows the address points (green dots) at risk of flooding (red dots) based on a 9 meter flood height within the basin (DwnStrm) when there is no dam installed at the Norris Dam location. The HAND raster is also displayed, showing the areas of minimal height above the nearest drainage point in meters.

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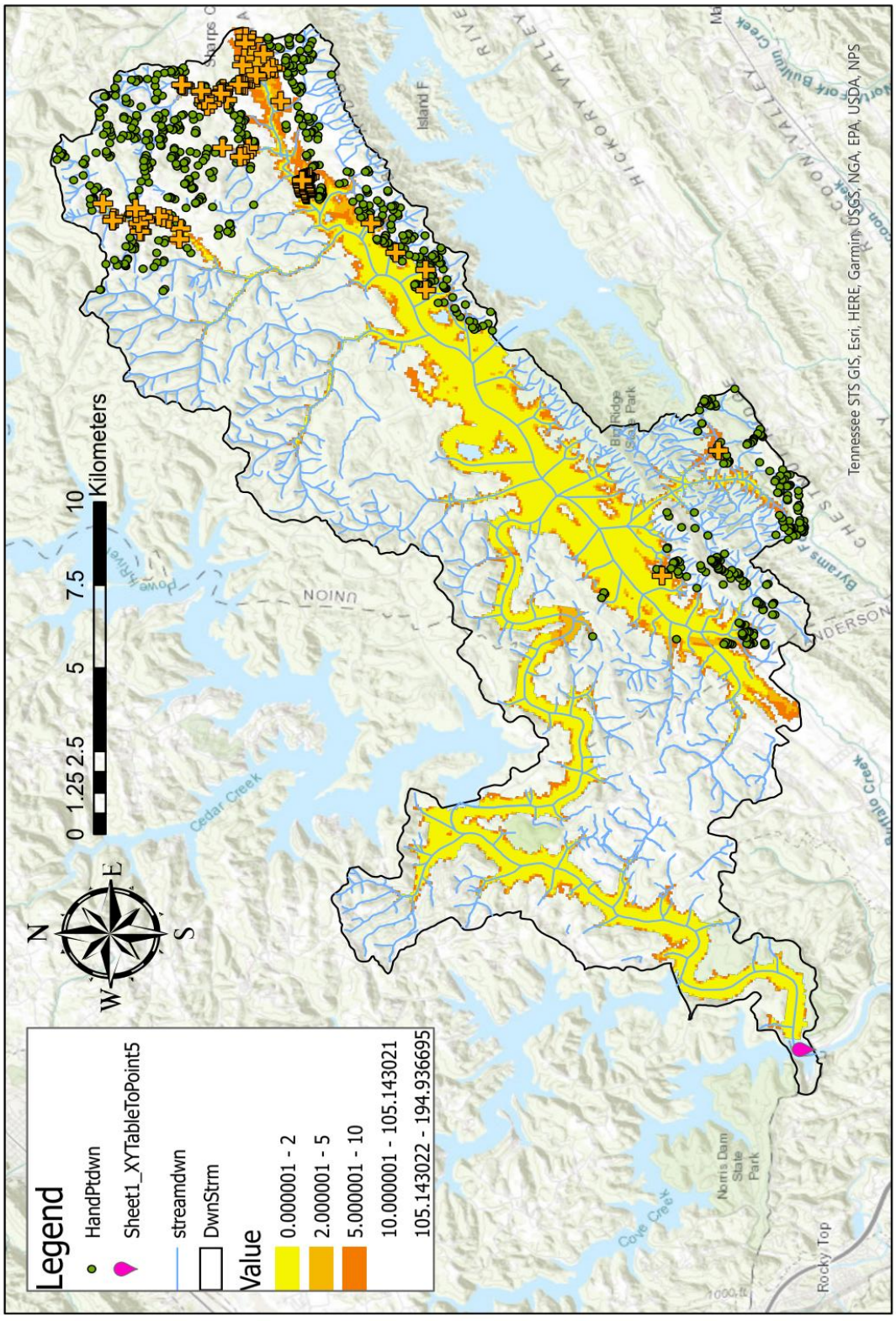
APPENDIX D – MAP 3



Norris Dam Flooding Potential

Created by Jessica Erben

Map 3: This map shows the address points (green dots) at risk of flooding (orange crosses) based on a 9 meter flood height within the basin (DwnStrm) when Norris Dam is installed. The HAND raster is also displayed, showing the areas of minimal height above the nearest drainage point in meters.

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