Geospatial Technology Approach to Lake Sidney Lanier Impoundment Volume Change and Sediment Erosion Analysis

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Abstract:

❖ Lake Sidney Lanier is a man-made reservoir constructed in 1956. It is a key fresh water source for Metro Atlanta, a population of more than 6.5 million. As urbanization has occurred at a rapid pace all around Lake Lanier, the impact to its watershed has been significant. As sedimentation and erosion happens throughout the watershed, they are transported and deposited further downstream creating a loss of volume within the impoundment area as well as hampering its water quality. TMDL study in 2017 found a large portion of the lake is impaired for algae. The goal of this study was to determine locations that are eroding at the highest rate and at the greatest potential risk of environmental impact. This study made use of the RUSLE model and the SWAT model to analyze soil erosion and status of the impoundment.

Materials and Methods:

❖ Five types of data were collected, processed and analyzed to calculate impoundment volume and sediment erosion. Topographic maps, Digital Elevation Models (DEM), Bathymetry, Land Use, and Soil were all used to complete this analysis.

❖ Using these data the following final products were created with software mentioned: 1) Manual contour digitization of USGS topographic maps ranging from 1891 to 1964 and converted to elevation data, 2) Revised Universal Soil Loss Equation (RUSLE) automated geospatial model development to obtain spatial soil loss information from the watershed, 3) Elevation Profile Change analysis with preimpounding period (1952) DEM and present (2010) bathymetry raster, and finally 4) Soil and water assessment Tool (SWAT) modeling in QGIS for 1891, 1964, 2010 to determine sediment transport through streams to the lake

❖ Data
- Topographic Maps (1891, 1952, 1964)
- Digital Elevation Model
- Bathymetry Data
- LULC (1974, 2016)
- Soil Data (gSSRUGO)

❖ Software
- ArcGIS Pro 2.6
- ArcGIS ModelBuilder
- QSWAT
- SWAT+ 1.2.3

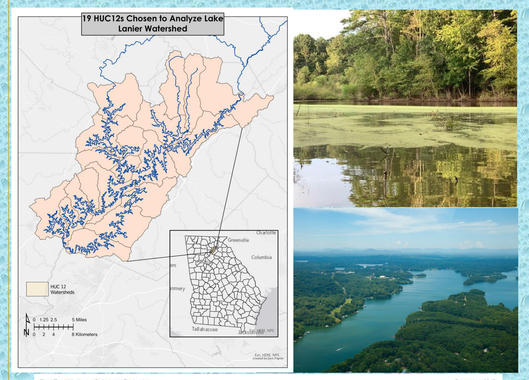
❖ Formula
- RUSLE Formula: (A = R x K x L x S x C x P)
- Model automation

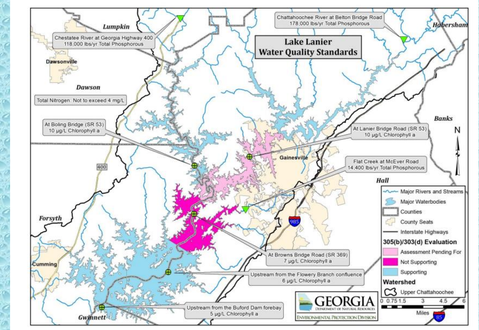
Geospatial watershed Models:

❖ The SWAT model was employed for 1891, 1964, and 2010. This provides pre-impoundment, post-impoundment and current impoundment status. The SWAT model simulates quality and quantity of surface and groundwater and predicts the environmental impact of land use and land management practices

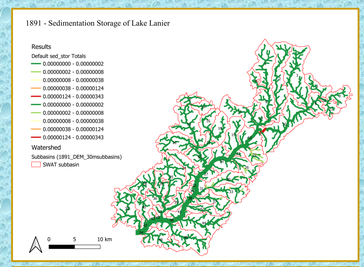
❖ The RUSLE model was used to analyze current soil erosion rates within the watershed to determine areas that pose the greatest risk to the impoundment.

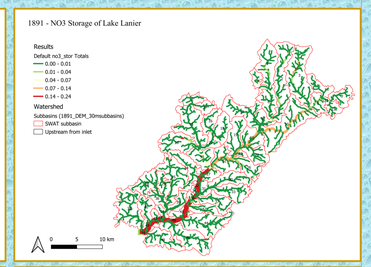
Study Area:

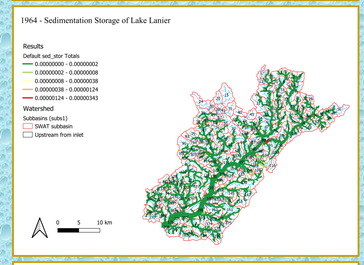


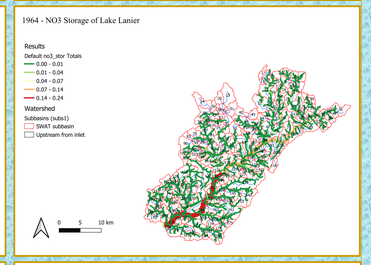


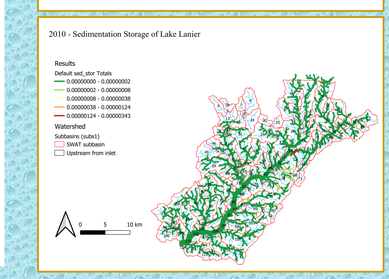
SWAT Model Results:

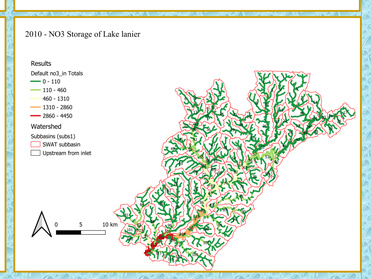




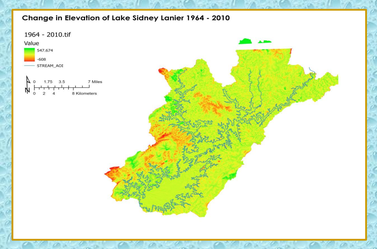




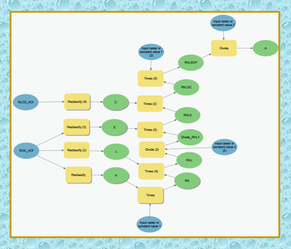


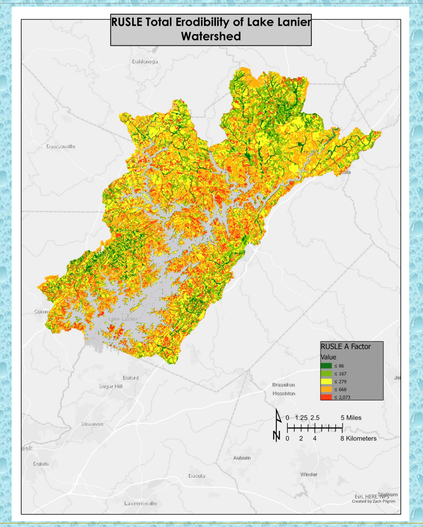


Change in Elevation 1964 - 2010:

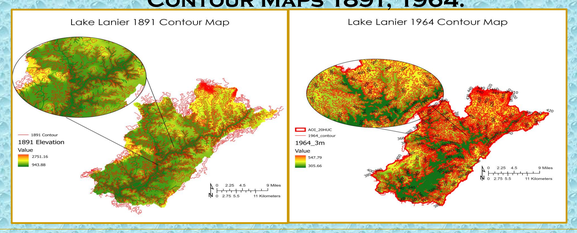


RUSLE Model and Results:





Contour Maps 1891, 1964:



Results and Discussion

❖ The SWAT model helps to visualize the erosion and sedimentation that is happening throughout the watershed and identify key problem areas

❖ The RUSLE model identifies areas that are eroding at the greatest rate. Which are mostly along banks and nearest to the impoundment area itself.

❖ The overall results from this analysis show that there is a concerning trend throughout the Lake Lanier watershed. Sedimentation is occurring that needs to be addressed.

Challenges and Lessons:

❖ Initial plan for the project was to verify findings in the field. This was delayed due to COVID-19 pandemic but will be completed in the future.

❖ Lake bottom soil samples were to be collected and tested in laboratory to correlate with watershed areas showing the expected origins of erosion and transportation could not be completed.

❖ Manual digitization of this study area was tedious and time consuming. A more efficient process of developing DEMs from digital topo maps is of need.

❖ Analysis over a time scale as large as this project creates several issues. Namely, accurate data for all dates.

❖ This project will continue to be updated with the addition of data from 1954, immediately prior to the development of Lake Sidney Lanier.

Program of Study and Goals:

I attend the University of North Georgia and am studying Environmental and Spatial Analysis and Biology. I will graduate fall 2020 and am currently in the process of applying to graduate school. I plan to continue to develop my skills in geospatial technology as well as broaden my horizons into other fields. I plan to focus my research on water resource management and environmental impacts of urbanization. Hopefully, the research I aim to complete will assist environmental decision makers in making effective decisions about our water quality and quantity. My goal for my future is to be able to make a difference and help protect our natural resources.

Collaboration and Contributions

Sudhanshu S Panda, Professor, UNG
Johnny M Grace III, Engineer, USDA-Forest Service
Devendra M Amatya, Hydrologist, USDA-Forest Service