Sedimentation and Heavy Metal Accumulation of Lake Conestee

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Abstract

The purpose of this study is to assess the connection between industrial soil contamination and sedimentation. The research focuses on Lake Conestee Nature Park in Greenville, South Carolina as a case study to determine the effect that sedimentation flow from Greenville has had on the downstream nature park. I used soil contamination and sedimentation data collected previously by an environmental consulting firm and elevation data from the South Carolina Department of Resources. I mapped the historical accumulation of sediment into the lake and used GIS to perform spatial analysis to determine whether there is any significant pattern of toxin concentration and how that relates to the hydrology of the area. This study has not proven any tangible connection between patterns of distribution in the two, but leaves it open to future query.

Introduction / Lit Review

Lake Conestee Nature Park is located south of the city of Greenville, South Carolina in the United States. It sits in a watershed of about 65 square miles, including the city. The park was established in 2000, when it was purchased by the Conestee Foundation Inc., a non-profit conservation organization (North Wind, Inc. & Blue Ridge Environmental Consulting, Inc., 2006). The Greenville area has a long history of agricultural exploitation and human-induced sedimentation. The land was intensively cultivated with cotton fields, then abandoned when the soil was no longer arable. This left the uplands eroded and the bottomlands destroyed. In the 1900s people began moving into urban areas for jobs, many lands were abandoned and reforested. The Soil Conservation Service was formed in the 1930s to deal with the erosion issue, and was eventually able to decrease the sediment runoff. Since the 1950s, an increase in urban development has caused an increase in sediment runoff and has altered the geomorphology and hydrology of the area (North Wind Inc., 2008). Sedimentation from industrial sources also may carry a plethora of heavy metals and chemical toxins that can adversely affect the soil productivity downstream. These soil contaminants can affect the survival of different plant species in the environment and thereby shape the surrounding community. Lake Conestee was created as a mill pond in 1830 by the construction of a dam, which was then replaced in 1892 (North Wind, Inc. & Blue Ridge Environmental Consulting, Inc., 2006). Because of sedimentation, which has filled the lake 95% volumetrically, 101 of 124 acres of the lake has become terrestrial land (Pinnacle Consulting group, 2005). The sedimentation not only changed the topographic environment, but soil from industrial sources carries a plethora of heavy metals and chemical toxins that can adversely affect the soil productivity. These metals could have consequences on both human and ecological health. The purpose of this study is to assess the connection between sedimentation, and heavy metal soil contamination to determine how human activity has historically affected the ecological health of this lake system.

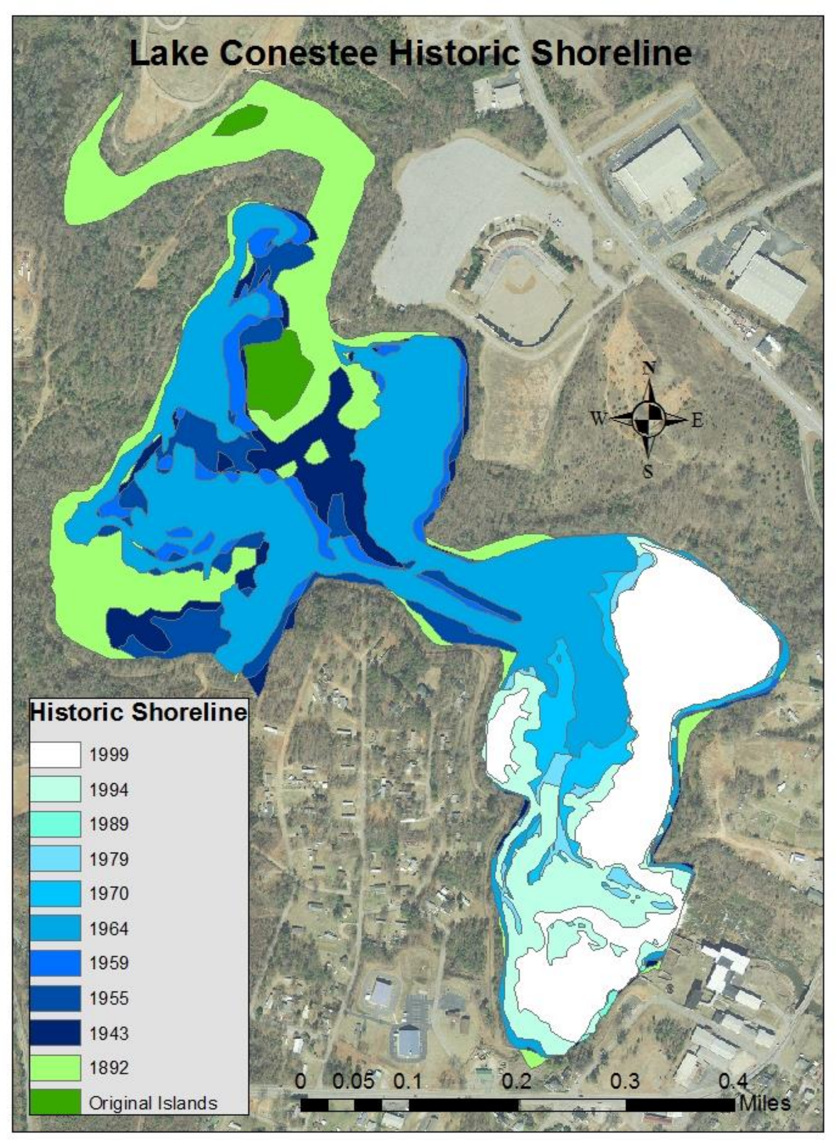
III. Methodology

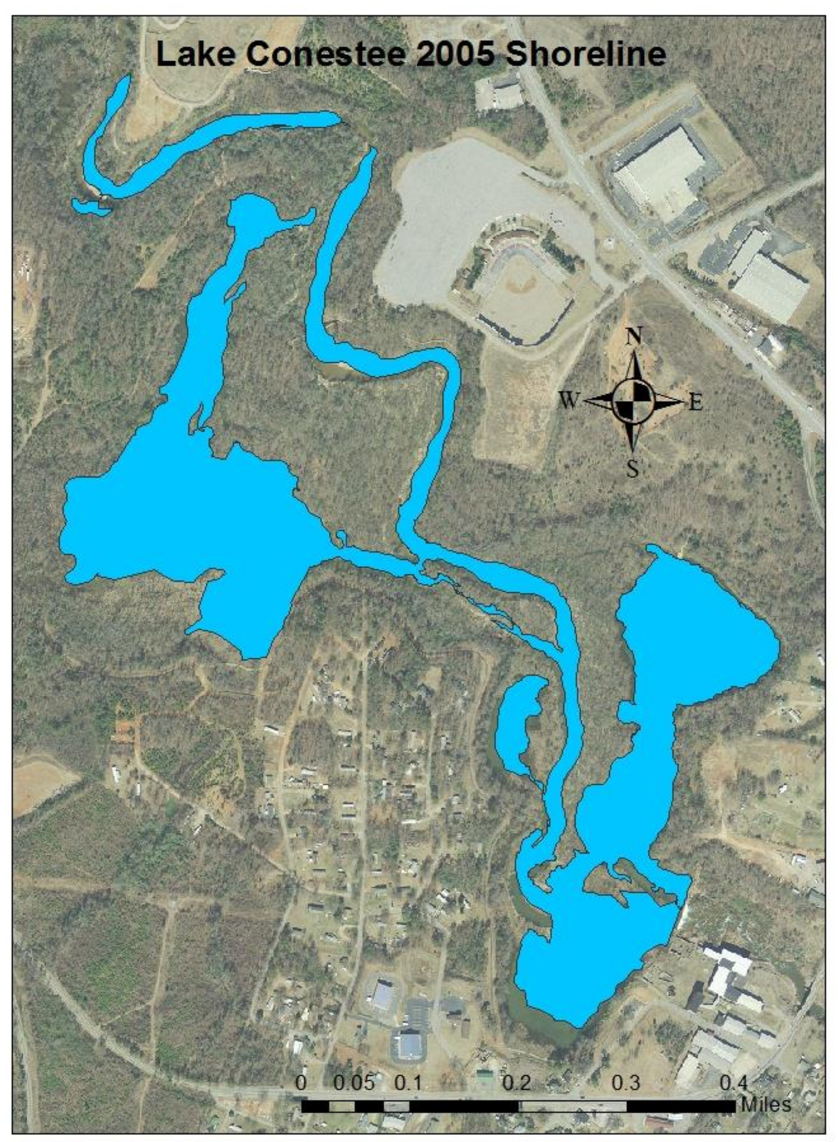
Historical Sedimentation

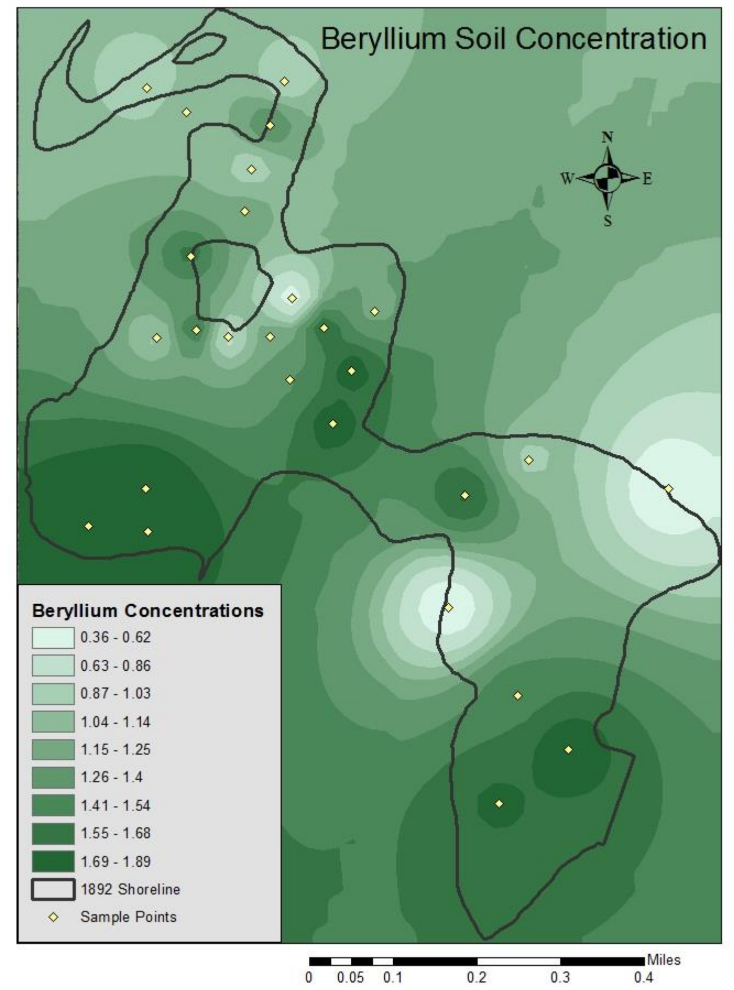
Aerial images were used to estimate the lake boundaries over time. These aerial images were georeferenced into ArcGIS, and the lakes were outlined and made into shapefiles. These shapefiles were then overlapped to produce a map that represents the change of the lake's shoreline over time due to sedimentation. The area of these shapefiles were also used to estimate the surface area of the lake, the results of which were entered into a data table and graphed

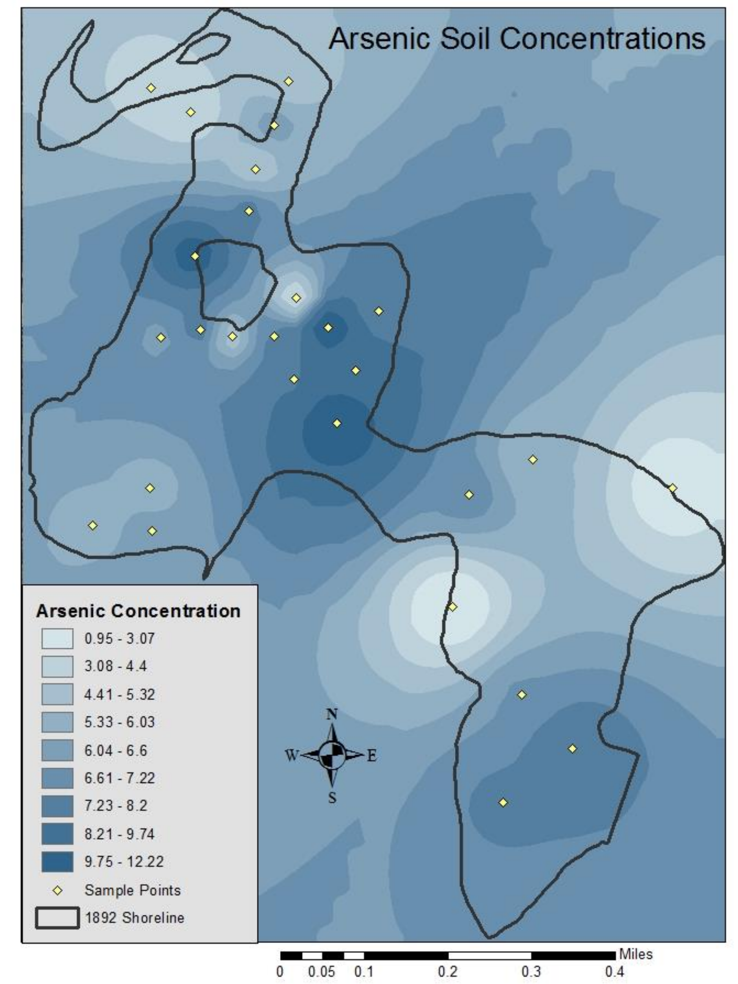
Metal Concentrations

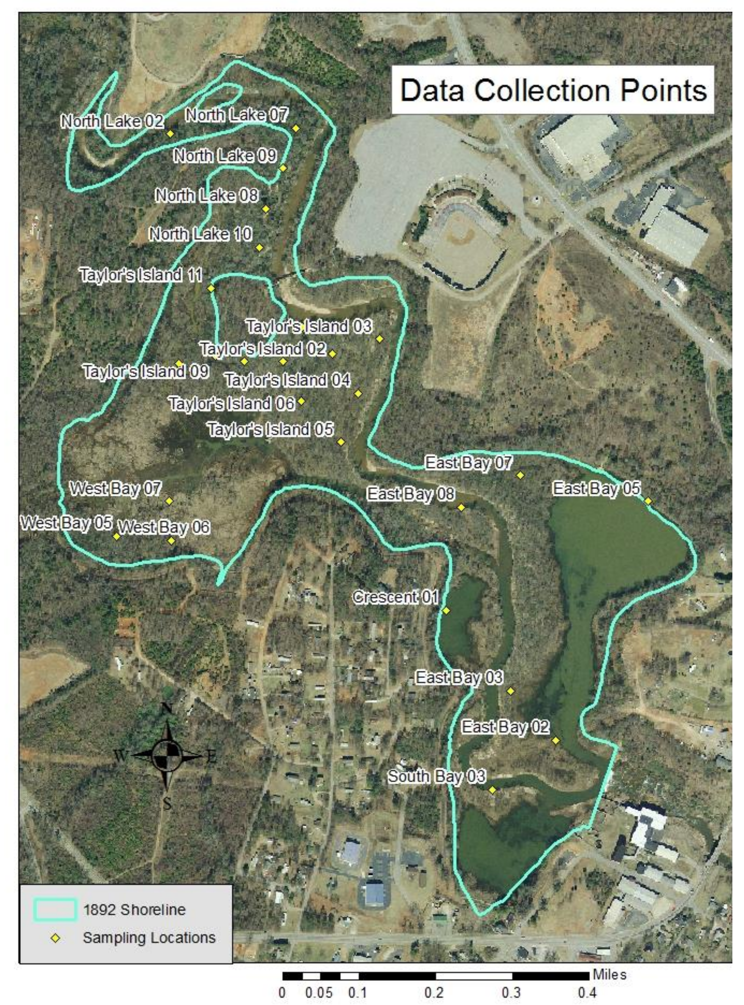
Data collected by the Pinnacle Consulting Group was provided by The Conestee Foundation. The data included the concentrations (in ppm) of 23 different metals in the terrestrial soil of 27 sampling sites in the Lake Conestee area. To determine the location of these sites, a map of the sampling locations was georeferenced in GIS, the points were made into shapefiles, and the metal concentration values were joined to the georeferenced points. Then the IDW tool was used to interpolate a raster surface from points using an inverse distance weighted technique. This produced a representation of the metal concentrations that could be compared to other factors.

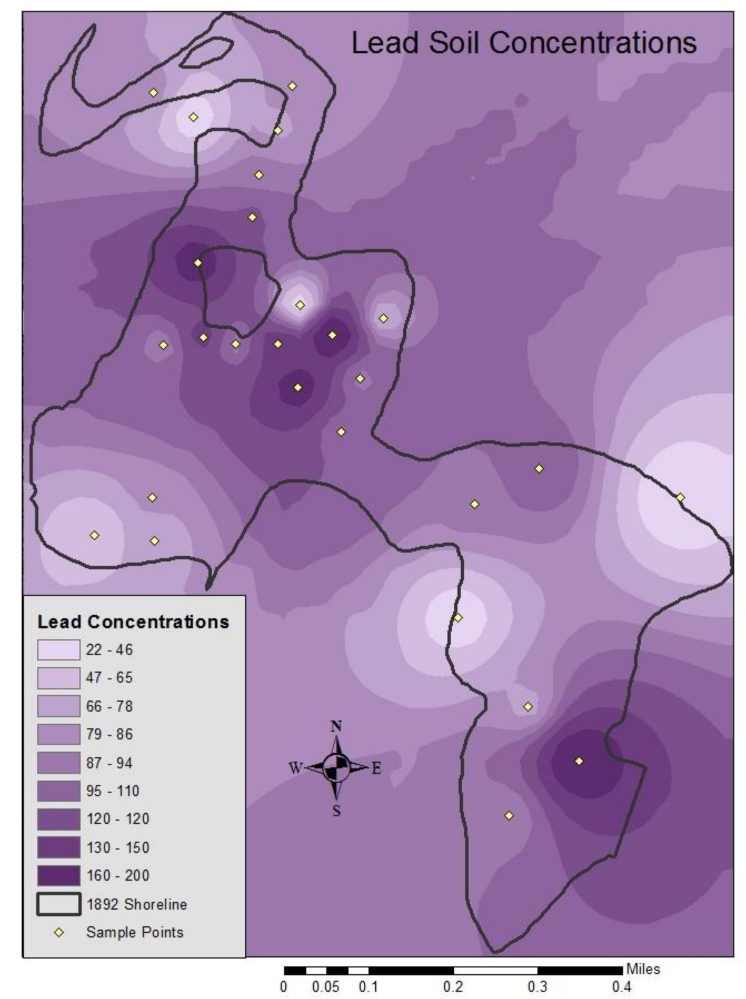








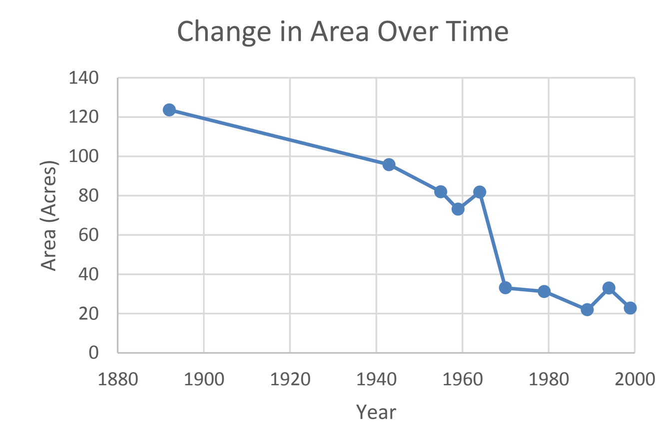




IV. Results and Discussion

The Historic Shoreline Map shows how the lake has filled in over time. The northern portion and the west bay were the first to experience sedimentation. By 1970, the entire upper portion of the lake was filled in, with small creek and the Reedy River flowing through it into the lake. The lake continued to shrink until 2000, when the dam broke. The approximate area of the lake for each year that the shoreline is recorded is listed in the table. From the area, the change per year is calculated to show a rough estimate of sedimentation rates. This shows a steady decline in the area. There is a dramatic drop in area from 1970 to 1979, indicating an increase in sedimentation. This may be due to increased urbanization of Greenville and construction upstream from Lake Conestee.

When the soil samples were taken in 2005, the lake had regained much of its upper portion. A soil concentration map was created for 23 heavy metals that were sampled. A variety of patterns were exhibited in the data. While no two metals were exactly alike in distribution, there were some general areas of importance. The Taylor Island area, and the South Bay generally had higher concentrations of metals. The upper East Bay, and the northern portion of the lake generally had low metal concentration. The West Bay was represented in both extremes. Lead and Arsenic, among other metals showed lower concentrations in the West Bay. However, Beryllium, among others, were found in high concentrations in the West Bay area.



Year	Lake Area (acres)	Change in Area	Years Past	Change (acres/year)
1892	123.56	0.00	0	0.00
1943	95.74	-27.81	51	-0.55
1955	81.90	-13.84	12	-1.15
1959	73.05	-8.85	4	-2.21
1964	81.83	8.78	5	1.76
1970	33.04	-48.79	6	-8.13
1979	31.21	-1.83	9	-0.20
1989	21.85	-9.36	10	-0.94
1994	32.88	11.02	5	2.20
1999	22.71	-10.16	5	-2.03

V. Conclusion

This study was intended to determine if there was a correlation between patterns of sedimentation and heavy metal soil accumulation in Lake Conestee. The patterns of sedimentation was mapped using historic shorelines, and compared to the measured concentration in the soil. These patterns do not match. Therefore, it does not support the hypothesis that sedimentation rates has had a direct or visible impact on the metal accumulation in the soil. It is possible that historic soil patterns and heavy metal accumulation are related, but that there are other factors that also have affected the distribution of metals in the soils. One possibility is the local hydrology. Differences in elevation could cause metals to accumulate. This idea is supported by the accumulation of heavy metals in the soil surrounding the Taylor Island area, which has a higher elevation compared to surrounding land, and in the South Bay, which is the final sink of water before the dam. More work must be done to explain the patterns found in this study.

V.I. Future Research

There is much future research that can be done in this area. If field work is possible, more recent information on metal concentration in the soil could be measured to determine how it has changed since 2005, to see if this has an affect on the results. Further research on the historical land use would provide more insight into the change in sedimentation rates. Also, further research into hydrology should be done to determine whether this has been a more prominent factor in determining the distribution of contaminants in the terrestrial soil.

VII. References/ Data Sources

References

1.North Wind, Inc., & Blue Ridge Environmental Consulting, Inc. (2006). *Ecological risk assessment*. Greenville, SC.

2.North Wind, Inc. (2008). *Prediction and modeling of sediment sources, loading rates and deposition in the Saluda-reedy watershed.* Accessed at: http://www.saludareedy.org/resInDepthReports.html

3. Pinnacle Consulting Group. (2005). *Sedimentation in major Saluda-Reedy watershed impoundments*. Accessed at: http://www.saludareedy.org/resInDepthReports.html

Data Sources

1.Pinnacle Consulting Group, Inc. (2004). *Targeted brownfields assessment – phases I & II*. Greenville, SC.

2. Statewide DEM for SC. (2010). Retrieved November 20, 2014, from South Carolina Department of Natural Resources website: http://www.dnr.sc.gov/GIS/descdem.html

VIII. Acknowledgements

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LAKE CONESTEE NATURE PARK

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