AN ASSESSMENT OF THE IMPACT OF RETENTION PONDS FOR SEDIMENT TRAPPING IN THE ADA CREEK AND LONGWOOD COVE USING REMOTELY Sensed DATA AND GIS ANALYSIS

Sudhanshu Sekhar Panda
Associate Professor, GIS/Env. Sc.
Co-authors:
Richard J Skarda: B.S., Applied Environmental Spatial Analysis
Jitendra B Sharma: Professor, Physics/Remote Sensing

GAINESVILLE STATE COLLEGE
University System of Georgia

International Symposium on Erosion and Landscape Evolution
ASABE Specialty Conference
Anchorage Hilton Hotel, Anchorage, Alaska
Background

- Sediment loading with the runoff from the watershed is the main cause of runoff water quality.
- Runoff sediment loading increases pollution in lake and decreases the longevity of it.
- According to Gain (1996), retention ponds are the low cost and efficient structures to trap the sediments carried by storm water runoff to lakes or reservoirs.
- Dendrite shape lakes like Lake Sidney Lanier have most options to build retention ponds at several entry points of creeks to the lake.
Objectives

- The main goal of this study was to determine the impact of retention ponds for the purpose of increasing longevity of Lake Lanier by sediment trapping.

- The Objectives to achieve that goal was to:
  - Develop DEMs from 1955 Topographic Maps and present day bathymetry data using advanced geospatial techniques.
  - Develop a geospatial automated model in ArcGIS Model Builder to determine the soil erosion rate from the Ada Creek watershed.
Study Area

- Under study are Ada creek cove and Longwood cove that discharge to Lake Lanier.
- Ada creek cove has a dam built on it to create a retention pond, Lake Knickerbocker while Longwood Cove has no dam built on it.
Materials and Methods  
(DEM Creation before the Lake)

The method employed in the study was to compare interpolated topographies of the two coves before the lake was created (1955) and the present.

The pre-impoundment topography of both Lake Knickerbocker and Longwood cove was created by hand digitizing:

- Elevations from digitized United States Army Corp of Engineers (USACE) topographic maps were used.
- Georeferencing was conducted on Topo images and the contours were manually digitized into a point elevation shapefile.
- ArcMap’s Topo to Raster tool was used to create a Digital Elevation Model (DEM).
Materials and Methods
(DEM Creation for the Present Day)

Present day topography was created from the Hall County two foot contour map and bathymetry data collected for the study with a Hummingbird fish finder/GPS combo unit.

Over 10,000 depth readings were recorded over a period of three days using the instrument.

The data was converted to elevation shapefile after subtracting the depth from the lake level elevation.

Hall County 2' contour shapefile along with the point shapefile from the bathymetry survey were used to create an interpolated DEM using the Topo to Raster tool in ArcGIS.

create an interpolated DEM using the Topo to Raster tool in ArcGIS
Materials and Methods
(Elevation Change Detection)

The **Minus** tool in ArcGIS was used to subtract current DEMs of both cove sites. Negative numbers indicated deposition and positive numbers indicated erosion. Changes in soil deposition for both coves were detected to find the advantages of the retention pond.

**Materials and Methods**

**Elevation Change Detection**

Subtract Current DEM from 1955 DEM to Detect Change

1955 DEM

Present Day DEM

Change – Erosion or Deposition
Materials and Methods

(RUSLE use to amount the Retained Sediment)

✿ It was conducted on Ada Creek which has a dam built to retain the sediment

✿ An automated geospatial model was developed in ArcGIS 9.3 Model Builder to obtain annual soil erosion amount from the

✿ The slope raster was used to calculate a LS-factor.

✿ The LS factor was calculated by:

\[ LS = \left(0.65 + 0.456(slope) + 0.00654(slope)^2 \right) \times \left(\frac{98.4}{72.5}\right) \]

where NN is 0.2 for slope less than 1%, 0.3 if slope is between 1% and 3%, 0.4 if slope is between 3% and 5%, or 0.5 for slopes greater than 5%.

✿ C-factor was derived by reclassifying a land cover map into the appropriate c-factors with reference to Wischmeier & Smith (1978)

✿ K-factor was derived from SSURGO data for the watershed.

✿ Rainfall erosivity index of 275 was appropriate for the study.

✿ Conservation practice factor of 1 was used.
Results and Discussions
(Bathymetry Data Collection)

Ada Creek SONAR bathymetry reading

Longwood Cove SONAR bathymetry reading
Results and Discussions

(Elevation point shapefile generated from the 1955 USGS topo)
Results and Discussions
(DEM Comparison – Ada Creek Cove)

Results and Discussions
(DEM Comparison – Ada Creek Cove)

- Most of the changes in Ada creek cove are within a -10 to 10 feet range.
- The negative number represents the increase in elevation means sediment deposition.
- The positive changes of DEM represent the erosion and that was perhaps due to the scouring in the side of the cove of the water falling in high velocity over the dam that created Lake Knickerboker retention pond.
Results and Discussions
(DEM Comparison – Longwood Cove)

Legend
- longwd-shore-line
- Contour_lwd_55D1

lwd_55DEM

<VALUE>
- 993 - 1,044
- 1,045 - 1,082
- 1,083 - 1,119
- 1,120 - 1,157
- 1,158 - 1,194
- 1,195 - 1,232
- 1,233 - 1,270
- 1,271 - 1,307
- 1,308 - 1,345

Results and Discussions
(DEM Comparison – Longwood Cove)

- Sediment deposition in the Longwood Cove was more than 30 feet in many locations with some scouring of 1-5 feet in the side of the cove.
- Contains maximum percentage of the area with high deposition and with little scouring.
Results and Discussions

(Soil Erosion amounting from Ada Creek Watershed)

- The K-factor for the watershed ranges from 0.24 to 0.6
- The C-factor for the watershed ranges from 0.2 to 0.32
- The LS-factor for the watershed was from 0.34 to 0.54

(a) K-factor, (b) C-factor, and (c) LS-factor maps (raster) for the Lake Nickerboker retention pond watershed.
The soil erosion amount varies from less than 0.4 t/ha/year to 11.64 t/ha/yr.

Using Map Algebra, in ArcGIS, the total sediment load to the retention pond was summed up to 451.5 tons per year with a sediment delivery ratio of 0.1.

Entire retention pond will be filled in with sediment in the next 52 years if no soil erosion control measures in the watershed.
Conclusions

- This study found a significant difference in sedimentation in the two coves which was attributed to sediment trapping by the Lake Knickerbocker retention pond.

- Thus, we concluded that creation of retention ponds would enhance the longevity of large reservoirs, in this case Lake Sidney Lanier.

- It was found that 451.5 tons of sediment was obstructed in present day by the retention pond per year.
Conclusions

- It was also found that the entire retention pond (Lake Knickerbocker) will be filled in with sediment in 52 years if no soil erosion control measures are taken in the watershed.
- This study provided very advanced methods to develop DEM from old topographic maps using ArcGIS software.
- Also, this study provided insight about developing DEM from the contour line along with bathymetry data.
Thank You