The Bathymetry of Furman Lake with a Runoff Survey of the Surrounding Land

Cameron Moore

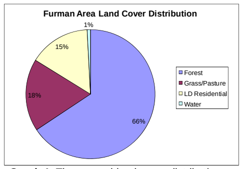
Department of Earth and Environmental Sciences, Furman University

Abstract

In 2006, Furman University adopted a commitment to environmental sustainability as one of its foremost strategic goals. As part of this campus wide commitment, the university initiated the Furman Lake Restoration project aimed at improving the water quality of Furman Lake. In order to better understand the lake's ecosystem, a water budget is being constructed that measures all of the physical hydrologic inflows and outflows. This project represents a small part of the water budget, the purpose of which is twofold. The first objective is to simply gain a better understanding of the different fluxes that go into and out of this small lake, and the other reason for the study is to aid in the construction of a nutrient budget for the lake. Accomplishing both goals will hopefully assist in the restoration project.

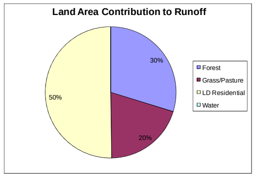
Background Information

A water budget is a necessary component in the visualization of the hydrologic dynamics of the lake. In the case of Furman Lake a six month water budget is being established which will lead to both a more quantitative general knowledge of the volumes of water entering and exiting the lake and a valuable nutrient budget analysis. Accomplishing both goals will hopefully assist in the restoration project. A water budget is an essential component to effective hydrologic management, a field which will become increasingly important as the world population continues to swell and people demand more of already over allocated surface water resources.



Graph 1. The general land cover distribution for the images displayed in figures 1, 2, and 3.

Figure 1. Original unprocessed image of Furman University



Graph 2. Runoff contributions adjusted for land area represented.

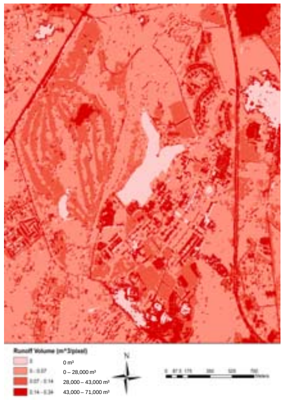


Figure 2. Runoff volume analysis in cubic meters per pixel (left) and total cubic meters of land area (right of legend).

Figure 3. Runoff depth analysis measured in centimeters

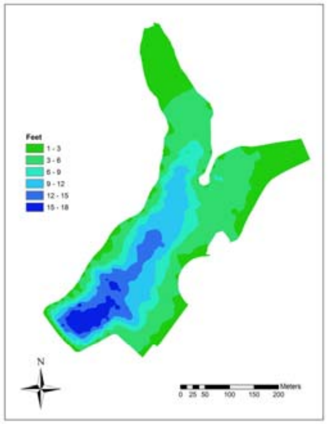


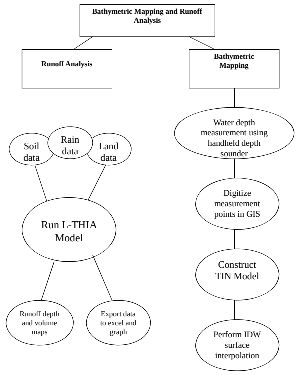
Figure 4. Bathymetric depth map of Furman Lake

Data Collection and Processing

Developed at Purdue University, the L-THIA model is a program for estimating runoff based on three key variables: land use classification, soil data, and thirty year precipitation records. Land use and soil data was taken from the extensive amount of data stored on the Furman GIS network and the precipitation records were obtained from the L-THIA website. All of this data was compiled and managed in ArcView 3.2 where the L-THIA model extension was used to run the analysis.

Data for the bathymetric analysis was obtained by taking depth readings along transects in Furman Lake. Annette Trierweiler and I collected 340 individual depth readings over a period of four days. In ArcMap 9.2 I manually digitized each point onto an image of the lake so that I could have x, y, and z coordinates (lat/long and depth). From this point I was able to proceed with my 3D analysis by constructing a triangular irregular network. Finally, to fill in gaps and predict depths in unmeasured locations, I used the inverse distance weighted method of interpolation which, put simply, weighs points located near sample locations more heavily than those further away.

Project Methodology



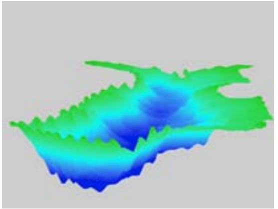
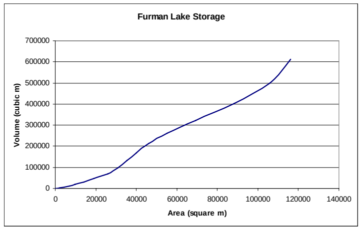


Figure 5. Three dimensional view of Furman Lake

Results and Discussion

The original image used in the runoff survey of the Furman area can be seen in figure 1. The L-THIA analysis generated two maps: the runoff volume map (figure 2) and the runoff depth map (figure 3). Values for the runoff depth map are given in cubic meters per pixel. The majority of the land falls under the category of forest which receives between zero and 28,000 m^3 of runoff water volume per year. The runoff depth map shows that this same land area receives a maximum runoff depth of 1.1 cm per year. If these statistics are taken at face value they can be somewhat misleading because total percent type of land cover is not taken into account. For instance, graph 1 reports that forested land is the most prevalent land cover type around the university. Therefore, it would be expected that the total runoff volume for the forest will be higher than that for other land cover categories simply because more forest exists. Graph 2 shows the relationship when runoff normalized and distributed over sheer land volume for each category (except, of course, for water). The bathymetry of Furman Lake is shown in figures 4 and 5 with figure 5 being a three-dimensional representation of the lake. Maximum storage capacity of the lake is 726,630 m^3 and the surface area at this volume is 116,101 m^3. Storage capacity for a range of depths is given in the table next to graph 3, the storage capacity graph . As would be expected, the graph shows that volume increases in roughly equal proportions to surface area.



Graph 3. Comparison between the relationship of water volume to lake surface area.

Depth (m)	Area (m^2)	Volume (m^3)
0.3	116101	610529
0.6	105806	498344
0.9	88398	401867
1.2	69193	322412
1.5	55139	261342
1.8	46055	211209
2.1	39843	168455
2.4	35269	130929
2.7	30888	97802
3.0	25858	69352
3.4	19091	46797
3.7	13985	30379
4.0	9653	18631
4.3	6970	10403
4.6	4209	4739
4.9	2208	1767
5.2	836	289
5.5	9	0.37

Conclusions and Future Work

The runoff maps in this study are meant to serve as a general glimpse of the magnitude of runoff the Furman area and Greenville area receive on an annual basis. The next step is to perform a runoff analysis on the section of the Saluda River basin that lies upstream of Furman University. This project represents only a small portion of the overall water budget of Furman Lake and is still in its infancy with regards to the data that has been gathered and processed. As research progresses and more information is collected everything will be integrated into ArcMap which will hopefully prove useful to the administration at Furman University as they work towards there ultimate goal of cleaning the lake.

Acknowledgements

Thanks to Annette Trierweiler for helping collect all of the depth readings and to Dr. Suresh Muthukrishnan whose advice helped guide this project toward completion.

References

Projection used: NAD 1983 UTM Zone 17N
Datum: D North American 1983
Data layers used: Bathymetry layer including digitized points created by myself
Furman land cover layer created by Dr. Suresh Muthukrishnan.
Precipitation data was obtained from http://www.ecn.purdue.edu/runoff and the L-THIA model can be found here as well.