Mapping Soil Characteristics for Optimizing Water Use on Furman's Green Surfaces

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I. Abstract

Water conservation is increasingly securing a place on national and global agendas despite decade-old studies warning of the scarcity of renewable fresh water. Even in the Upstate of South Carolina where water availability has posed little danger in comparison to the peril of neighboring Atlanta, conservation-minded strategies would serve the region well as rapid development becomes wasteful sprawl. In low-density suburban areas like Furman, irrigation (and other "outdoor uses") account for a majority of water expenditure. This project aims to (1) create a GIS based map of a designated area on campus of the irrigation system (2) identify excess usage within its irrigation system based on soil characteristics and (3) make suggestions for a lowered total output from the sprinkler heads without compromising the aesthetic quality of the grass. The results show that, due to clay-rich and compacted soils, huge amounts of water go to runoff daily from a poorly planned and maintained irrigation system that puts out unnecessary and unequal flow. Much research and work remains to be done before Furman can claim a "wise-use" status on water.

II. Introduction

As Furman celebrates fifty years on its emerald campus, the history of the land, more specifically the soil, dates back much further.

• The original Furman campus was made up of the following soils (Fig. 5); Cecil and Hiwassee Series soils, that are formed from weathered granite, gneiss, and schist, were originally *moderately permeable* (SSURGO).

• Over the years this area has had many different uses, however it was mainly used for the cultivation of cotton. This agriculture and the construction of the Furman Campus severely compacted the soil making it nearly impervious (up to 70-99%) (Gregory et. al, 2006).

• The irrigation system feeds nearly five million (4,751,492) square feet of "green surfaces" on campus, which is composed of various turf grasses that already need an excess of water.

•Furman Lake pumps out 30% of this water; the other 70% comes from the city (see Fig. 4).

•As the campus has expanded, new sections of irrigation lines have been installed resulting in a fragmented system lacking central control. However, the Furman Grounds maintenance is in the process of installing a "central command system" this very minute.

• Sprinkler heads are frequently replaced with heads of different flow rates, making estimate of total output volume difficult.

• Overall, the irrigation system has many different problems within itself and this research will help jumpstart the streamlining process.

III. Methodology

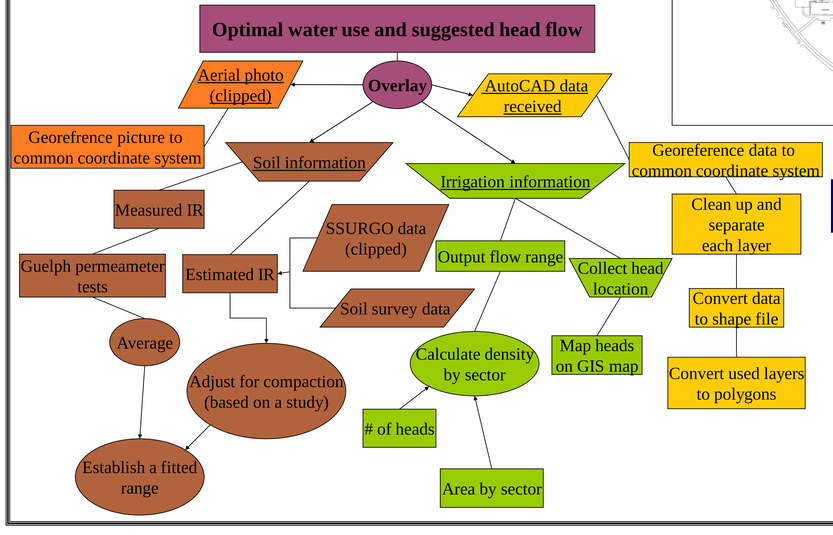
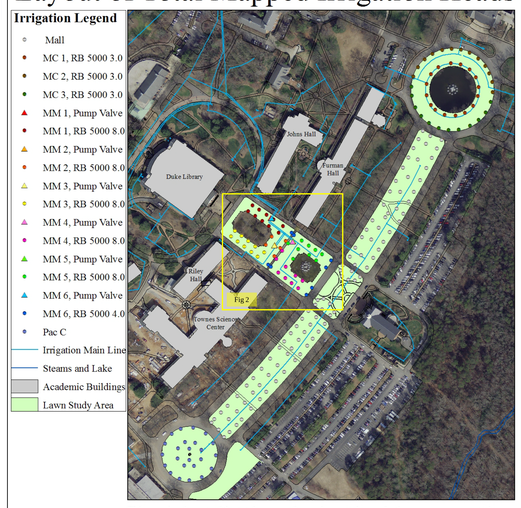


Figure 1

Layout of Total Mapped Irrigation Heads



This map is a layout of the total area we focused our study on. In these areas, represented by the Lawn Study Area polygons, we mapped every irrigation rotor head in the area and then sectioned them into their generic zones (MC=Main Circle; MM=Milford Mall). We also focused in on the Milford Mall section and further sectioned them by their specific zones also mapping where each pump valve is located.

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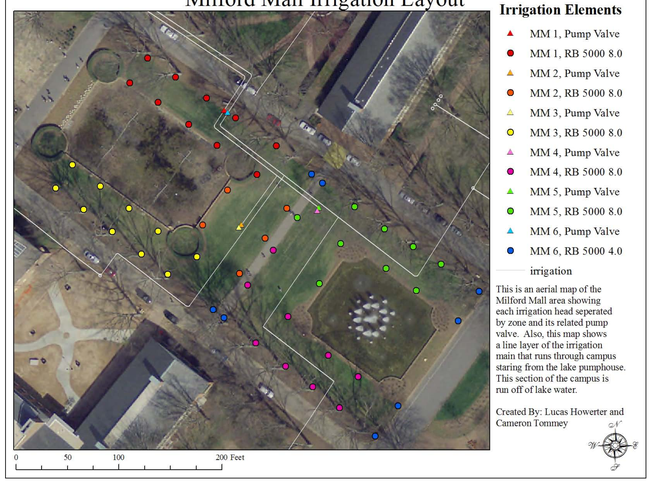
Figure 2

Milford Mall Irrigation Layout



This is an aerial map of the Milford Mall area showing each irrigation head seperated by zone and its related pump valve. Also, this map shows a line layer of the irrigation main that runs through campus staring from the lake pumphouse. This section of the campus is run off of lake water.

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Figure 3

Zone	# of heads	type of head	psi per head	Flow (gpm) for 1 head	total flow per 20min
1	10	RB 5000 8.0	≈58	8.86	1772 gal
2	5	RB 5000 8.0	58	8.86	886 gal
3	10	RB 5000 8.0	55	8.86	1772 gal
4	9	RB 5000 8.0	54	8.86	1594.8 gal
5	9	RB 5000 8.0	55	8.86	1594.8 gal
6	6	RB 5000 4.0	56	4.44	532.8 gal
		Total water used for Milford Mall			**8152.4 gal**

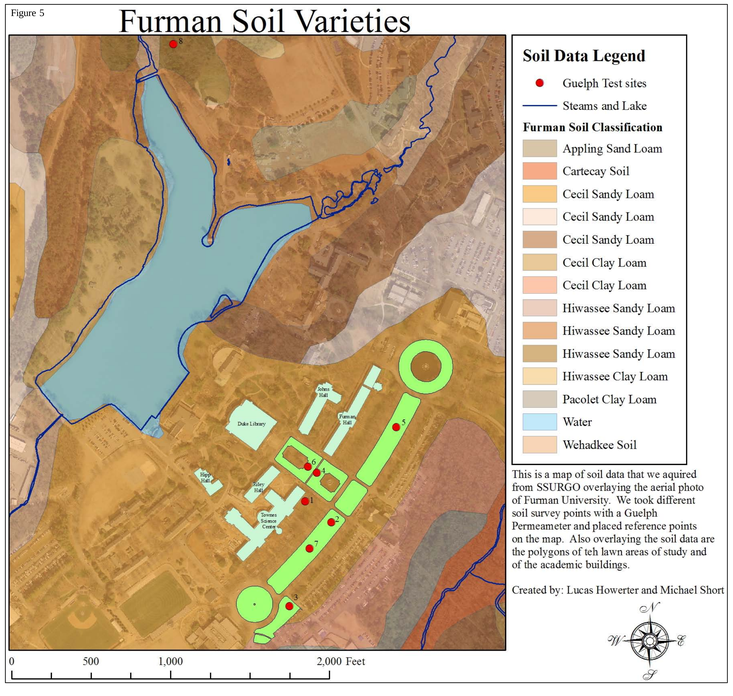
Figure 4

Lake Vs. City Water used on irrigation

AutoCAD map provided by Astrid Truman

Figure 5

Furman Soil Varieties



This is a map of soil data that we aquired from SSURGO overlaying the aerial photo of Furman University. We took different soil survey points with a Guelph Permeameter and placed reference points on the map. Also overlaying the soil data are the polygons of teh lawn areas of study and of the academic buildings.

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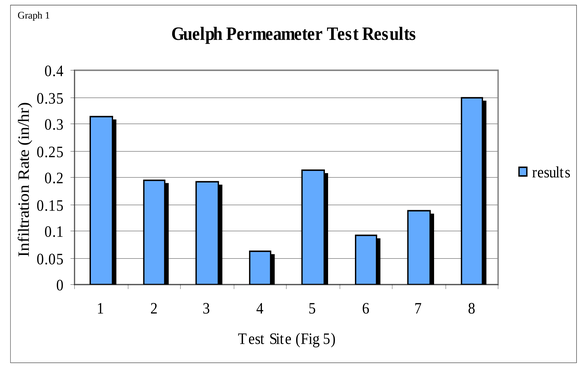
IV. Results/Discussion

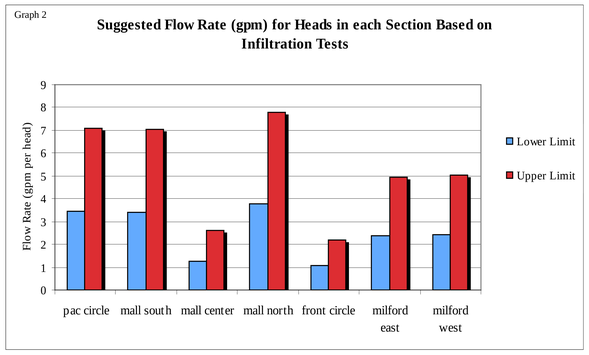
Perhaps this project's biggest contribution to the university is the establishment of an average range of infiltration rates for Furman's campus. As explained in the introduction, the Greenville County Soil Survey, showing the different types of soil in Fig. 5, provides a range that can no longer be considered accurate due to the land's history. Our range, 0.194-0.4 inches/hour, comes from (1) measured rates of eight tests with a Guelph Permeameter (see Graph 1) and (2) estimated rates from the soil survey that were adjusted for compaction from percentages given in a previous study (Gregory et. al, 2006).

Graph 1



We used this established range to inform our suggested flow rates per head (see Graph 2). Any flow above the upper limit (determined using 0.4 in/hr) will become runoff because the infiltration capacity has been exceeded and any flow below the lower limit will not be efficient to fully water the area.

Graph 2



The study area is divided into 7 sections (see Fig 1) for which we manually counted irrigation heads and digitally measured the area in order to calculate the density of heads.

The two sections of Milford Mall (Fig. 2) together put out 8152.4 gallons of water in 20 minutes (see Fig. 3). Of that total, 5688 gallons become runoff determined by our calculations. To remedy this problem, the flow rate of each head would have to be reduced to our suggested rate (Graph 2), or the time would have to be restricted to approximately 6 minutes.

V. Conclusions and Future Work

The information gathered from our study area reveals:

• The permeability of soils on campus is considerably less than documented in the soil survey, which estimates a range of 0.6-2.0 inches/hour.

• Large amount of water is being wasted in the form of runoff because of this characteristic.

• Quantifying total water output proves difficult because the type and amount of sprinkler head is not fully known and hence the rate at which water flows from the heads is not known.

• Further pursuing this research and mapping the entire irrigation system could save vast amounts of water and money as suggested by the Milford Mall example, a tiny fraction of the total green surfaces on campus.

VI. Acknowledgements

We would like to thank Dr. Suresh Muthukrishnan and the rest of our GIS class for all the help they provided us throughout the term; Scot Sherman and Andy Medgyesy for all of their help in showing us the different aspects of the irrigation system; Dr. Weston Dripps for teaching us how to use the Guelph Permeameter; Astrid Truman for providing the various AutoCAD maps for us; and lastly we would like to thank Cameron Tommey for helping us with the research.

VII. References/ Data Sources

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