Using GPS to Map Soil Conditions in Turf Areas

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Introduction

The increased emphasis on efficient water usage in the turf industry has increased the need for site specific management. Because of this, the use of sensors to measure the water content in soils has become increasingly popular. The Toro Company has developed the PrecisionSense™ 6000 (PS6000) which is a machine that measures soil volumetric water content, soil compaction, soil salinity, and turf vigor. It is equipped with a Global Positioning System (GPS) which allows the measurements to be geo-referenced to the site where the data was taken.

The increased focus on head injuries in athletics has led to an interest in the hardness of athletic fields throughout the field. This interest has led The Toro Company to develop The mobile hardness tester which measures the Gmax of the surface.

The objectives our study were:

1. To determine the correlation between volumetric water content and soil compaction
2. To determine the correlation between volumetric water content and Gmax.
3. To determine the correlation between soil compaction and Gmax.

Materials and Methods

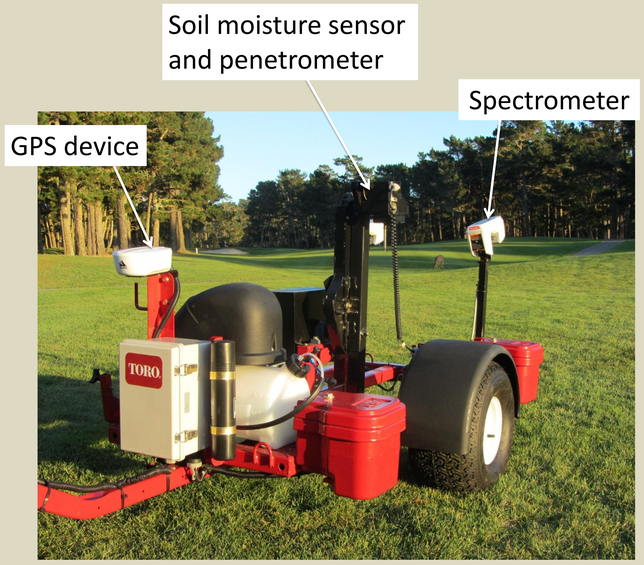
- In 2011, six soccer fields were sampled with the PS 6000 and the mobile hardness tester in the Minneapolis, MN metro area. Three fields were sand based while three fields were native soil.
- The Kelley, MLN, and UMNP fields are the native soil fields while the MLS1, MLS2, and UMNG fields are the sand based fields.
- On each field irrigation flags were placed 4.5m (15ft) apart to provide equal spacing and the same paths for each machine. The paths were marked so the measurements from the PS 6000 and the mobile hardness tester would be taken in the same general location.
- The PS 6000 and the mobile accelerometer are pulled by a Toro Heavy Duty Workman which pulls the PS 6000 at 3.06 Km/hour and the mobile hardness tester at 2.58 Km/hour. The arm on each machine is gear driven and rotates so that measurements can be taken at about every 2.4m (8ft).
- Once the data has been collected, the data is converted into a .60m x .60m (2'x2') grid. The converted data is then uploaded into Google Earth where it can be displayed as a map which shows the moisture, compaction, or vigor values for the entire field.

Figure 1. Correlation between the variables for each field sampled. The italicized numbers in red are significant at 0.05.

	Field								
Relationship	Kelly	MLN	UMNP	MLS1	MLS2	UMNG	Native	Sand	All
Comp vs. VWC	*0.11602*	*0.38473*	*0.25476*	0.01314	*0.07342*	0.02187	*0.09496*	*0.24163*	*0.29698*
GMAX vs. VWC	*0.42935*	*0.09478*	0.05688	0.04716	*0.30031*	*0.09963*	*0.30349*	*0.15593*	*0.36381*
Comp vs. GMAX	*0.58641*	*0.19366*	*0.23659*	*0.20017*	*0.32101*	0.06583	*0.53595*	*0.22859*	*0.48274*

Conclusions

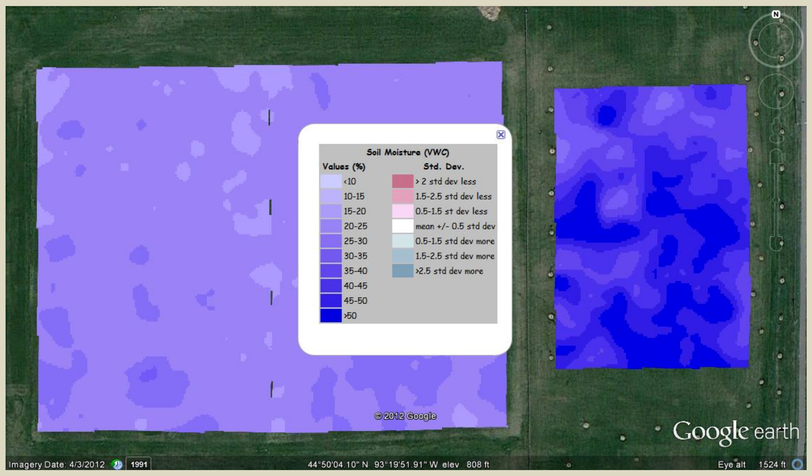
- For all fields, the correlation between each pair of variables is significant.
- For the native soil fields and the sand based fields, the correlation for each pair of variables is significant.
- The sand based soccer fields have fewer instances where the correlation between each pair of variables is significant.
- The correlations with higher sample sizes all have significant correlations while the correlations with smaller sample sizes have fewer instances where pairs of variables are significant.



PS 6000

Mobile Hardness Tester

PS 6000 sampling a golf course fairway



An example of data displayed in Google Earth. By looking at the data in Google Earth the variation in soil moisture can easily be seen across a field.