Art vs. Science-Based Irrigation Scheduling

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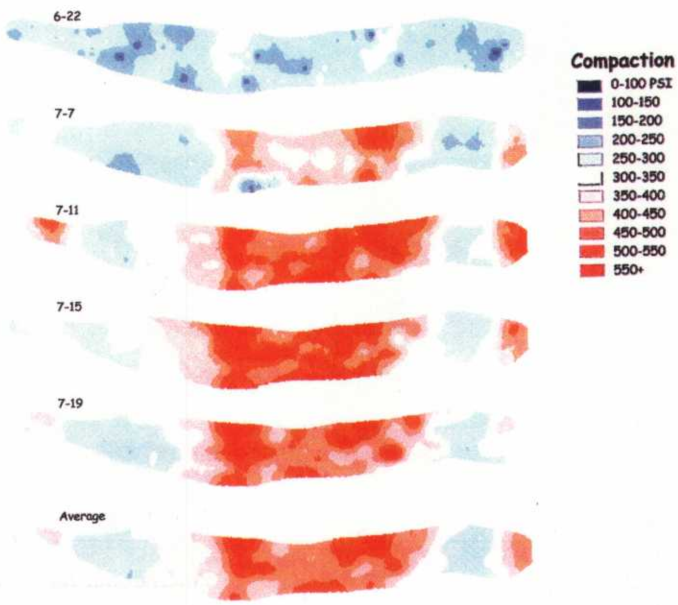
I was recently reading an article in a trade journal about using ET (evapotranspiration) for irrigation scheduling. The article painted the practice in very broad strokes, citing superintendents who used the practice and how successful they felt that it was. Most of them noted that there were other variables that needed to be considered when scheduling irrigation effectively thus making the practice more of an art than a science. Developing a system to help base irrigation scheduling more on scientifically based needs of the plant rather than using an ET rate calculation from a weather station in one corner of a course for whole course irrigation scheduling would seem to be in order.

To that end, I have been working with a company for the past five or so years to investigate a better tool to help take out some of the magic in irrigation scheduling and replace it with a stronger dose of science. We began with the premise that turf moisture needs were based not only on the amount of water lost but how much is available for the plant to access in the first place. We know of course, that there is any number of factors influencing soil moisture availability including turf type, soil type, compaction, ground contours as well as others. The first step was to better understand the site conditions for the irrigated areas. We sampled the soil throughout the area looking at soil type, soil moisture, compaction to extreme depths, at one point we even punctured an irrigation pipe, and our irrigation efficiency. To be sure that we had accurate maps these measurements were taken on a GPS based grid. After all this was done, we had detailed maps of many of the factors that would influence our irrigation needs.

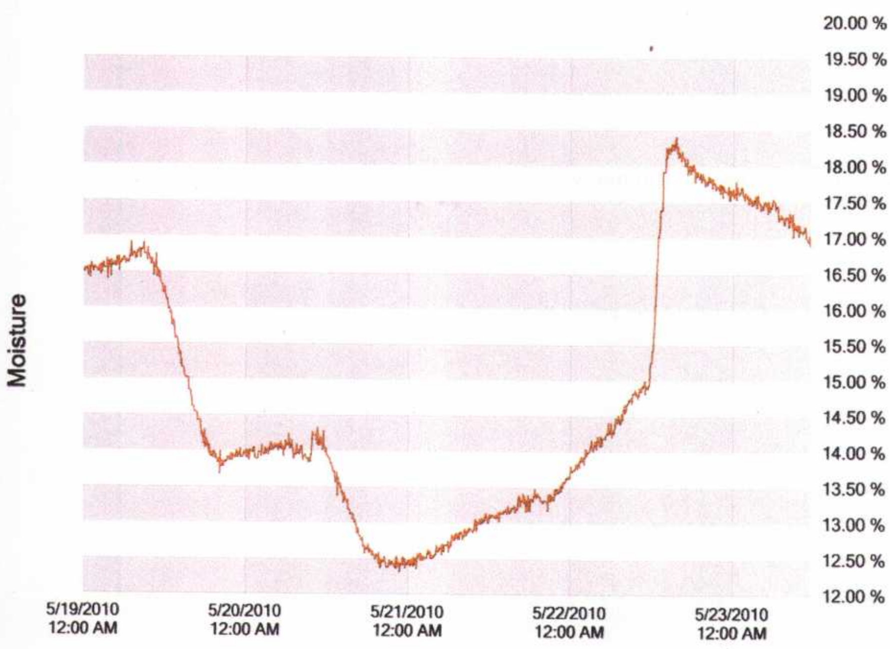
This data provided us a set of maps that showed general areas that were related in compaction and moisture content and generally speaking, soil type as well. This gave us a basis to start to look at how we could monitor those areas and see if we could indeed use these measurements to help us better irrigate the turf.



SOIL COMPACTION - 0-4″

Heritage Links #3: Soil compaction is expressed here as the amount of force in pounds per square inch (PSI) required to push a metal probe into the soil to a depth of 4″. Therefore, the measurement is the maximum value for compaction in the rootzone (0-4″).

We installed soil moisture sensors in two distinctly different areas on one fairway at two, four and six inches deep into the soil and began to collect data. After watching the soil moisture values and observing the Turfgrass over a number of years, I have a good understanding of what the data tells me about the moisture content in each of the different areas and how to use the data. There is still a bit of art, but it is based more on science than using the ET method. One of the major things that I have learned is that you can indeed predict the need for an irrigation event based on the soil moisture sensors; however, the trigger number is different depending on the time of the year. I am sure this has to do with root length, ET rates and a slew of other factors we have yet to figure out how to measure. By knowing when the soil is beginning to dry down I am able to irrigate ahead of when a stress point will hit thus reducing the need for syringing and spot irrigation. With these sensors you can even see how a rainfall event infiltrates the soil.



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Irrigation Scheduling-

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What we have shown is that by mapping out your course and finding turf areas that are similar in structure and turf type, the ability is there to use soil moisture monitoring to help better utilize your irrigation system and reduce water use. Additionally, a representative area with similar soil type and compaction can be used as an indicator for related areas throughout the course, so you don't need a thousand sensors, just enough to cover the different soil type areas you have. Granted, some adjustments will be needed for terrain differences and such, but we never thought the human input could be totally eliminated.

With a fairly good grasp of the technology, I have installed sensors in two of my greens and have been able to determine a trigger point where a hands on monitoring needs to take place. Where I would have irrigated before, I am able to know how much moisture is available to the plant and can even delay an irrigation event if there is rain in the forecast, thus preventing overwatering due to a moist green having to accept rain. Working with my golf professional, we have been able to develop an irrigation regime that keeps a green accepting a shot more consistently, even though it is much drier than in the past.

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- E. P. Eckholm CGCS

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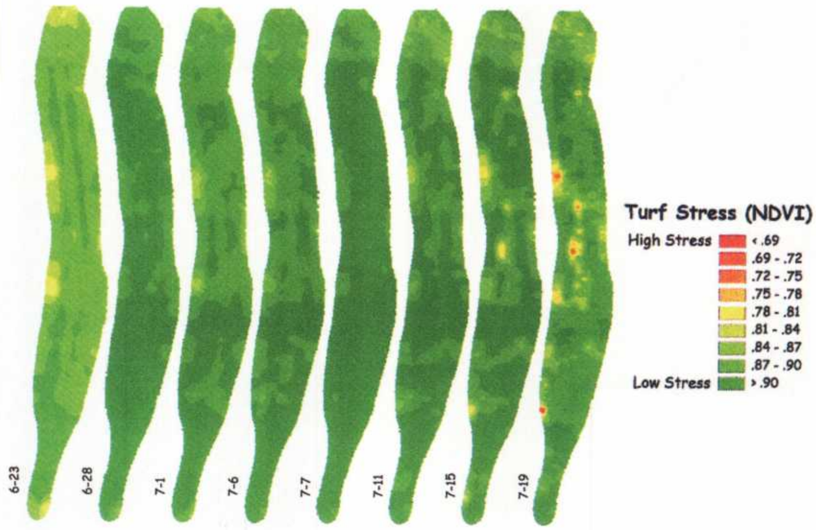
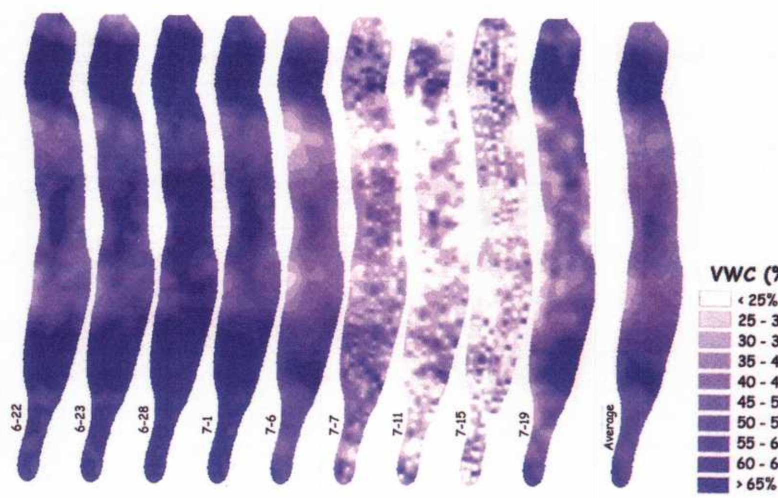
When this project started, I thought I was a judicious user of water, and knew that I irrigated less than many of my peers, what I found was that I too overwatered on many occasions. While I feel I now have a good handle on how to use this technology, new questions continue to pop up on how to make the system work better and continue to develop the data into a more hard set of science bases rules of use. Growing a healthy stand of turf will always require a good dose of art; however, I feel a strong base of science will go a long way to making our lives a lot easier.



TURF STRESS - REFLECTANCE AS NDVI

(Normalized Difference Vegetative Index)

Figure 2 *- Heritage Links #3: The earth is bombarded with energy from sunlight. Plants absorb specific wavelengths of energy (red and blue) found in the visible portion of the electromagnetic spectrum to fuel photosynthesis. Photosynthesis in turf is very responsive to stress. Therefore, the amount of red and blue light absorbed (or reflected) by the turf canopy is a reliable measurement of photosynthesis level or vigor/stress. Spectrometers are sensors that emit specific wavelengths of energy and measure the amount of each reflected back from the turf canopy. More red energy reflected back indicates a lower level of photosynthesis or a higher level of stress. Two stress indicators are used to map stress: NDVI and R/IR (red energy as a fraction f near infrared energy.)*



SOIL MOISTURE VWCO-4"

(Volumetric Water Content)

Figure 3 *- Heritage Links #3: Soil moisture data is collected using a sensing technique called "Time Domain Reflectometry" or TDR. Two 4" long metal probes are inserted into the soil. A high frequency electrical pulse is generated along the probes. The soil's moisture content affects the amount of time required for the signal to be reflected back to the probes. The duration of this response time is measured by the sensor and used to calculate soil moisture averaged to a depth of 4" and expressed as % volumetric water content.*