Irrigation Association's Soil Moisture Sensor Phase II Virtual Test

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Abstract

The Irrigation Association (IA) through its Smart Water Applied Technology (SWAT) effort has been working for the last decade to develop an independent third party testing protocol designed to evaluate control systems that "automatically" adjust irrigation events using either soil moisture sensors (SMS) or climatologically-based controllers. After extensive review and public comments recently, a second testing protocol has been developed, which links SMS response curves to a controller in managing irrigation schedules for six different virtual landscape zones. This protocol is designed to provide a similar test and evaluation method as established with the "Smart" climatologically-based controllers. It is hoped that the performance results of the two different operational platforms can be compared directly. This presentation will discuss the methods and outcomes derived from utilizing the new IA protocol based on SMS response curves as well as issues of compatibility of the "computer interface" used for this test.

Introduction

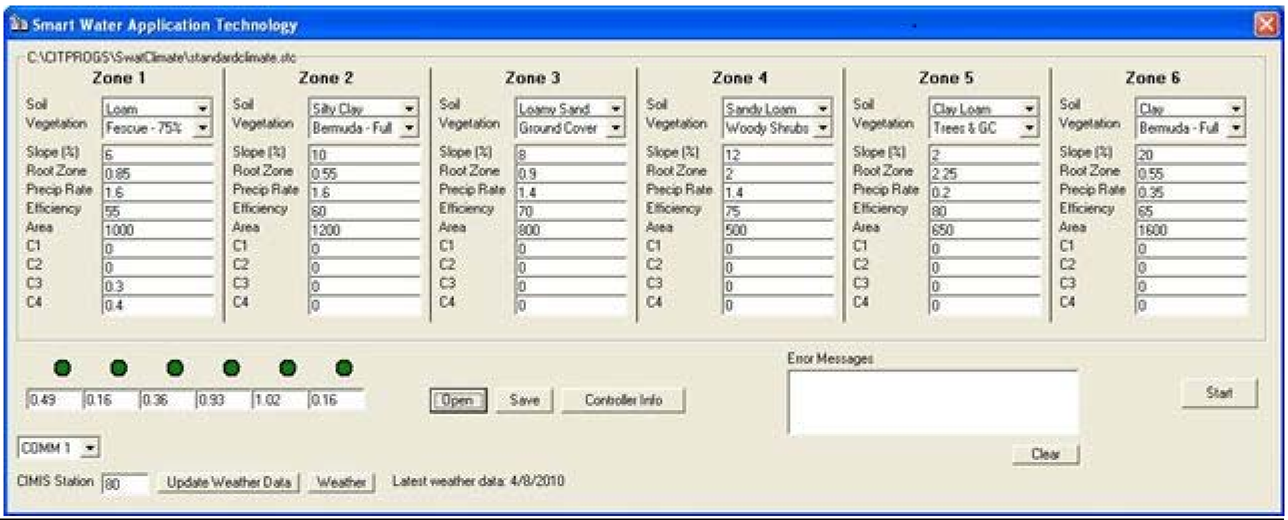
The overall goal of this project was to verify the efficacy of the IA Soil Moisture Sensor Phase II-Virtual Landscape test. In particular, this project focused on the application of standardized testing protocols on soil moisture sensors operating on different principles (Phase I) and translated it for Phase II Virtual Landscape testing. The evaluation concept used accepted formulas for calculating crop evapotranspiration (ETc) and a weather station on site to estimate the moisture balance, which was used by the controller to achieve efficient irrigation while minimizing potential runoff. There are allowances in this evaluation for variability in soil properties and the inherent problems associated with trying to characterize these problems to scientific instruments.

Proposed Work and Statement of Methodology

Participating manufacturers were required to submit a controller and/or controller interface module along with a data conversion device (computer interface). The data conversion device acted as the interface that accepted the most recent moisture data from the CIT monitoring computer and converted it to a format accepted by the manufacturer's controller under test (see additional details at www.irrigationorg/gov/swat_drafts-soil/).

The Phase II-Virtual landscape included six zones to accommodate a variety of soils, water quality, plant material, slope, temperature, exposure to sun, root zone storage, precipitation rate, application efficiency, and area. The individual zones within the landscape represented a combination of the factors stated above to represent a range of agronomic conditions.

The total accumulated moisture deficit over time was used to measure adequacy while the accumulated surplus of applied water over time provided the system efficiency. Any water applied above the soil water holding capacity was characterized as runoff or deep percolation, which lowers application efficiency.



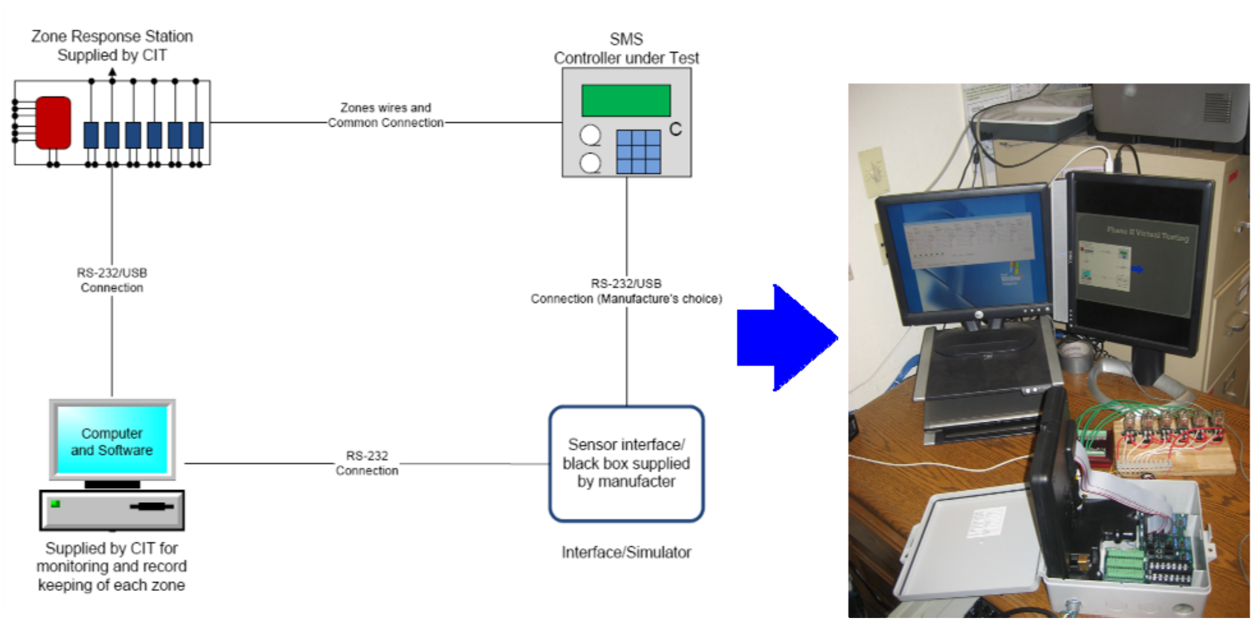


Figure 1: Schematics and layout of the Phase-II testing.

Results

Controllers from three manufacturers with different SMS operating principles were successfully tested during this beta testing phase and the following data ranges were recorded. (Given the complexities of the test development and small testing sample, it is premature to make comparisons between these beta testing results and results obtained using climatologically based controllers.)

- Irrigation Adequacy: 100 to 73.8 %
- Scheduling Efficiency: 100 to 25%
- Overall Efficiency: 100 to 70%
- Rainfall Efficiency: 100 to 80%

Irrigation Association - Smart Water Application Technology
Soil Moisture Sensor Based Controllers

International Center for Water Technology

Project Identification		
	Manufacturer	Black Box 1
	Model Number	
	Serial Number	
	Evaluated By	JO
	Date	October 1, 2010 - October 30, 2010
	Weather Station	CIMIS 80
	Reference No.	
	Comments	

Input Data	Parameter	Zone #1	Zone #2	Zone #3	Zone #4	Zone #5	Zone #6
	Soil Type	Loam	Silty Clay	Loamy Sand	Sandy Loam	Clay Loam	Clay
	Vegetation	Fescue - 75%	Bermuda - Full	Ground Cover	Woody Shrubs	Trees & GC	Bermuda - Full
	Slope, %	6.0	10.0	8.0	12.0	2.0	20.0
	Root Zone Stor., in.	0.85	0.55	0.90	2.00	2.25	0.55
	Precip Rate, in./h	1.60	1.60	1.40	1.40	0.20	0.35
	Efficiency, %	55	60	70	75	80	65
	Area, SQ-Ft	1000	1200	800	500	650	1500
	Soil Intake Rate, in./h	0.35	0.15	0.50	0.40	0.20	0.10
	ASA, in.	0.25	0.16	0.26	0.24	0.28	0.10
	Max. Run Time, min.	12.0	6.6	17.3	14.4	N/A	24.0

Evaluation Summary							
	ETo, in.	3.64	3.64	3.64	3.64	3.64	3.64
	ETc, in.	1.79	2.21	1.98	1.43	2.26	2.21
	Gross Rainfall, in.	0.64	0.64	0.64	0.64	0.64	0.64
	Net Rainfall, in.	0.52	0.52	0.52	0.52	0.52	0.52
	Eff. Rainfall, in.	0.52	0.52	0.52	0.52	0.43	0.52
	Gross Irr., in.	2.82	1.84	2.59	2.03	6.06	1.69
	Direct Runoff, in.	0.00	0.00	0.00	0.00	0.00	0.00
	Soak Runoff, in.	0.06	0.06	0.07	0.07	0.00	0.05
	Effective Irr., in.	1.38	1.07	1.80	1.40	6.38	0.99
	Deficit, in.	0.00	0.46	0.00	0.00	0.00	0.58
	Surplus, in.	0.00	0.00	0.00	0.00	3.51	0.00
	Irr. Adequacy, %	100.0	79.1	100.0	100.0	100.0	73.8
	Sch. Eff., %	94.4	94.6	96.2	95.2	44.9	95.1
	Overall Eff., %	51.9	56.8	67.4	71.4	35.9	61.8
	Rainfall Eff., %	100.0	100.0	100.0	100.0	82.7	100.0
	Cur. Moist. Bal., in.	0.61	0.10	0.71	1.61	2.25	0.10

Figure 2: A typical layout of a performance report.

Conclusion

The Phase II-Virtual Landscape testing technique reduced the testing time to 30 days, or until the minimum rainfall requirement of 0.4 inches and reference ETo of 2.5 inches were met. This could potentially save a considerable amount of time and energy compared to the conventional outdoor irrigation controller tests performed using real vegetative conditions. Further, this model of testing allows for most of the conditions except for ETo and rainfall, to be replicated each time and around the year for the different controllers being tested.

During this phase of testing we were able to resolve/address all the issues related to compatibility of the computer interface and a standardized description for the computer interface and the communication protocol was finalized for future reference. Now that we have a better understanding of how the entire process works, future testing can be conducted using the latest protocol (see the full draft protocol posted at the IA website for additional details).