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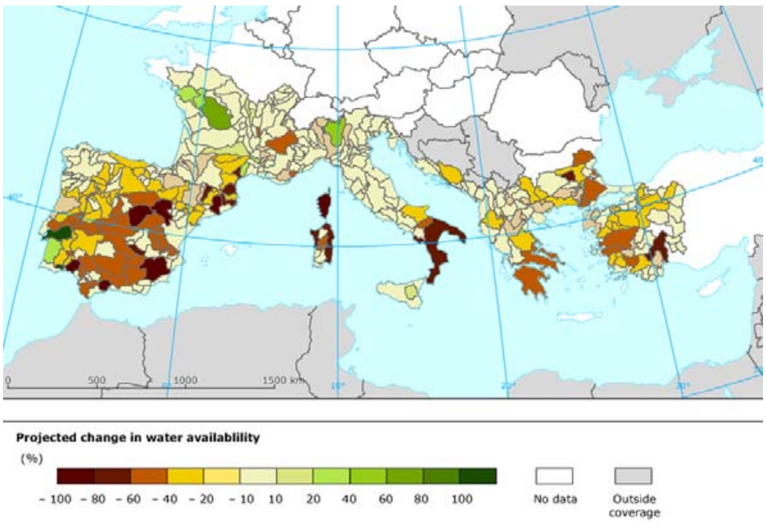
Evaluation of various sensors for irrigation management for urban landscapes

Ioannis L. Tsirogiannis [1,*], Nikolaos Malamos [2], Pantelis Barouchas [2], Chalkidis Iraklis [3]
Konstantinos Papakonstantinou [1], Penelope Baltzoi [1], Konstantina Fotia [1]

[1] Technological Educational Institute of Epirus, TEIEP Kostakii Campus, Arta, 47100, Greece
[2] Technological Educational Institute of Western Greece,
Theodoropoulou Terma, Amaliada, 27200, Greece
[3] University of Thessaly, Fytokou Str, N.Ionia, Volos, 38446, Greece
[*] Corresponding author E-mail: itsirog@teiep.gr

Water availability estimations



Source: CMMC, 2013

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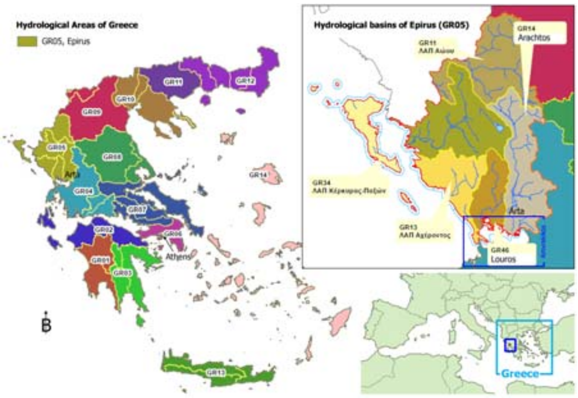
Background

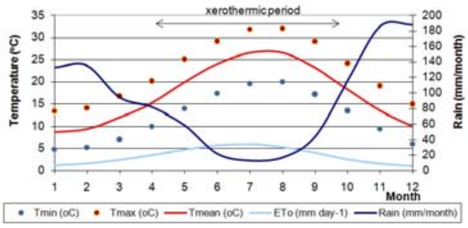
Source: IA, 2014

What we did in a glance

- A field study was conducted at the Technological Educational Institute of Epirus (Arta, Greece) in 2014.
- The purpose was to investigate the water conservation potential of various scheduling approaches with and without the use of special sensors (rain, solar energy, ET and soil moisture).
- Tall fescue, a cool-season turfgrass, was used for the evaluation as it is considered the most commonly used lawn grass in North and Western Greece.
- The objectives of the study were to investigate the water conservation potential of various irrigation scheduling approaches with and without the use of special sensors and to develop relevant practical recommendations to irrigation managers and home owners.

Area of the experiment





Month	ETo (mm day^{-1})	ETL (mm day^{-1})	Period characterisation
April	3.45	2.76	cool
May	4.69	3.75	
June	5.62	4.50	warm
July	5.91	4.73	
August	5.27	4.22	
September	3.97	3.18	cool
October	2.52	2.01	

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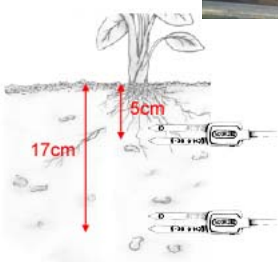
Ambient parameters + water delivered volume measurements



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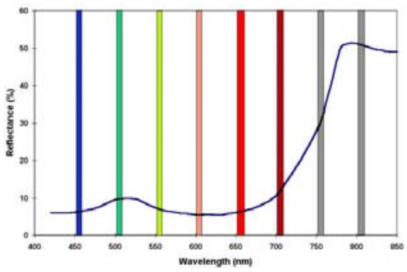
Soil characteristics, turfgrass root and canopy growth evaluation

Reflectance measurements for turfgrass quality evaluation

- PRI ((RX - RRef) / (RX + RRef))) equals to (R560 – R510) / (R560 + R510
- NDVI ((RNIR – RRed) / (RNIR + RRed)) equals to (R810 – R660) / (R810 + R660)
- where
  - R denotes reflectance at the specified wavelength,
  - X is a wavelength in the absorbance of xanthophyll pigments spectral region;
  - Ref is the reference wavelength for PRI measurements,
  - NIR is the near infra red and Red is the Red region of the spectrum.



Treatments

- 1_C Control: irrigation controller using water budget periods
- 2_R Rain: irrigation controller using water budget periods + rain sensor
- 3_S Solar: irrigation control using solar energy (as measured by a pyranometer) integration for continuous calculation of frequency
- 4_M SoilMoisture: irrigation controller connected to soil moisture sensor
- 5_TCL: irrigation controller connected to Evapotranspiration (ET) sensor + rain sensor

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1_C Reference

- The characteristics of the applied schedule were:
  - one irrigation event every 2nd day
  - start time at 5:30 in the morning
  - 15min initial run time per irrigation event which was lowered to 11min after using data from a system audit
  - water budget at 60% during the cool part of the irrigation period (1/4-31/5 and 1/9-31/10)

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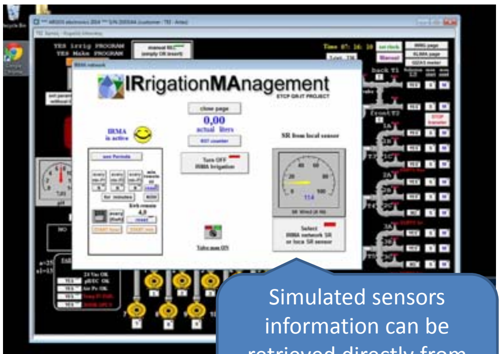
2_R Rain sensor

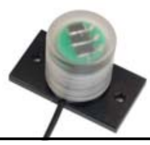
- For treatment 2_R the irrigation period was also divided in cool and warm section.
- Additionally, any irrigation was prevented after a pre-set level of rain has fallen.
- Once the rain passed, the rain sensor allowed the controller to resume normal irrigation.
- A Hunter Mini-Click Rain Sensor (Hunter Industries, USA) was used for rain control, and it was adjusted to 13mm,

3_S Solar Energy sensor

- 4 and 6.5 kWh day^{-1}, of solar energy are expected to reach the earth surface at the latitude of the experimental location during a sunny mid spring / fall and midsummer day respectively .
- 3_S system schedule:
  - one irrigation event every 2nd day (in other words, where 12 kWh day-1, of solar energy were summed)
  - start time at 5:30 in the morning
  - 15min initial run time per irrigation event which was lowered to 11min after using data from a system audit



Simulated sensors information can be retrieved directly from the system for any location in the area



4_M Soil moisture sensor

- Applied schedule:
  - one irrigation event per day (according to the suggestions of the manufacturer)
  - start time at 5:30 in the morning
  - 7.5min initial run time per irrigation event which was lowered to 5.5min after on-site adjustment

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5_TCL ET station

- The characteristics of the applied schedule were:
  - one irrigation event every 2nd day
  - start time at 5:30 in the morning
  - 15min initial run time per irrigation event which was lowered to 11min after on-site adjustment

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Results: climatic and meteo info

Month	mm month^{-1}			
	Climatic (20 y)		During the experimental period (2014)	
	ETo[a]	R[b]	ETo[a]	R[b]
April	103.56	81.50	2.06 (±0.17)	129.83
May	145.34	58.50	3.80 (±0.17)	74.43
June	168.67	21.80	5.38 (±0.16)	18.83
July	183.29	12.60	5.22 (±0.10)	7.20
August	163.42	17.20	4.75 (±0.07)	1.80
September	119.23	43.50	3.28 (±0.11)	123.80
October	77.98	115.00	3.46 (±0.10)	157.60

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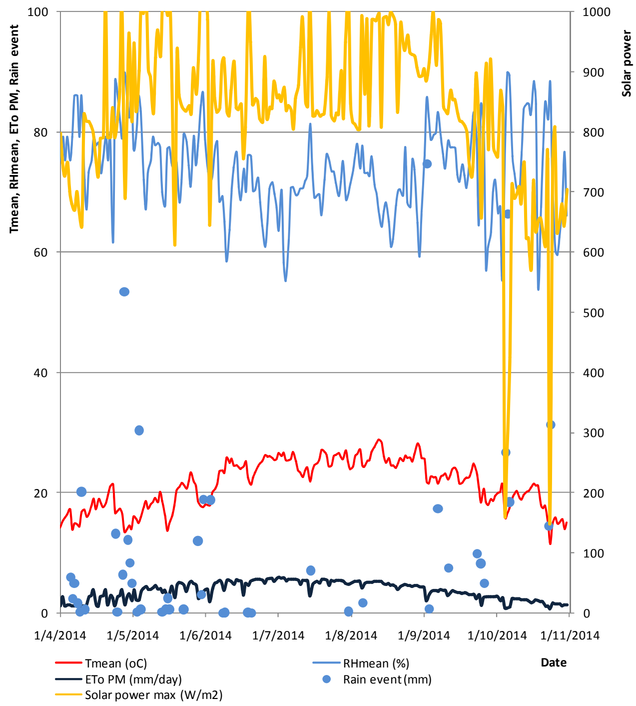
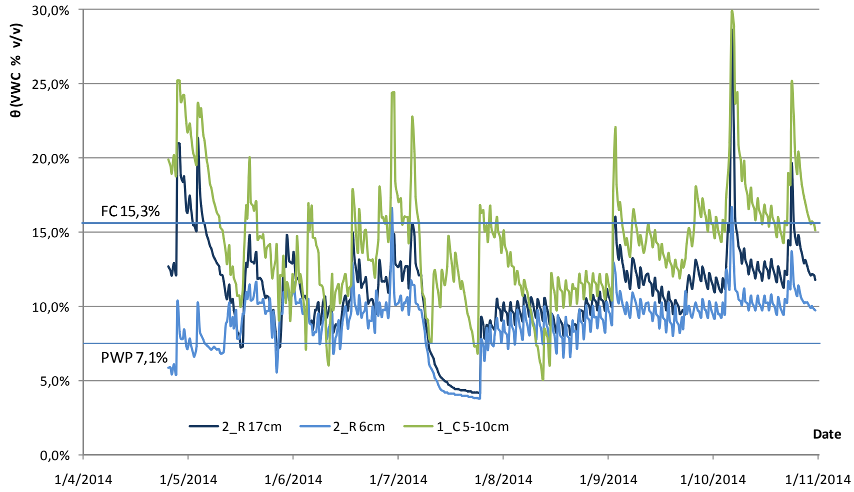
Solar radiation, T, RH, ETo and Rain events during the experimental period



Results: Soil moisture



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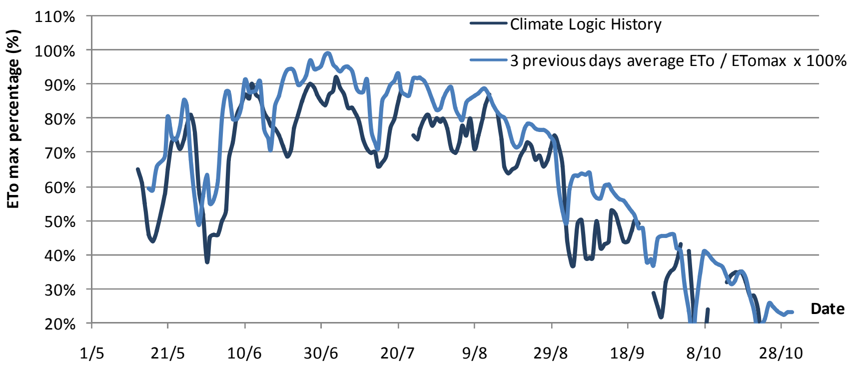
Results: The respond of Irritrol Climate Logic [case study]



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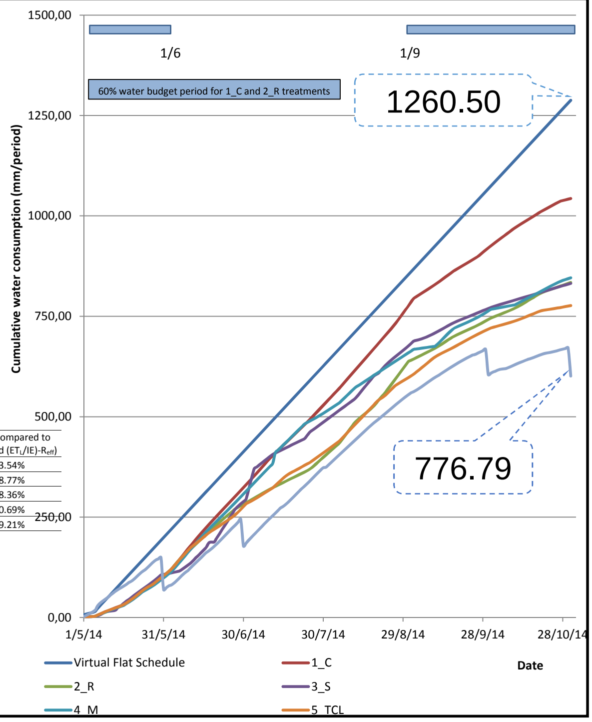
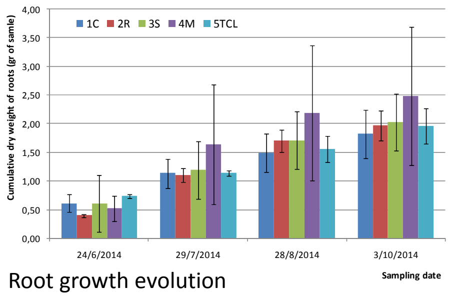
Irrigation water consumption



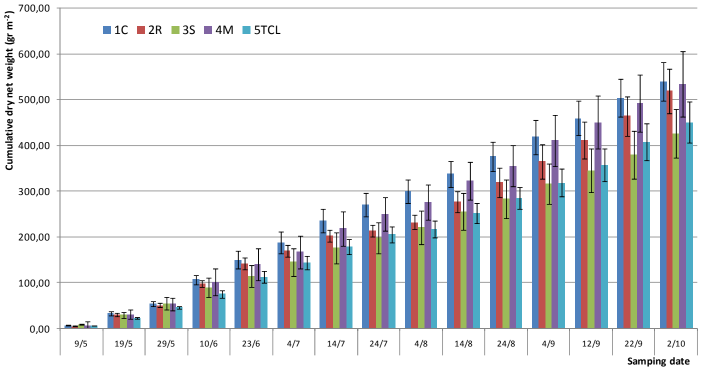
Treatment	Cumulative period value (mm)	When compared to virtual flat schedule approach	When compared to estimated $(ET_L/IE)-R_{eff}$
1_C	1043.33	-19.00%	73.54%
3_S	834.29	-35.23%	38.77%
4_M	831.81	-35.42%	38.36%
5_TCL	845.83	-34.33%	40.69%
$(ET_L/IE)-R_{eff}$	776.79	-39.69%	29.21%

Comparison of cumulative water consumption and estimated ETL

Turf grass growth



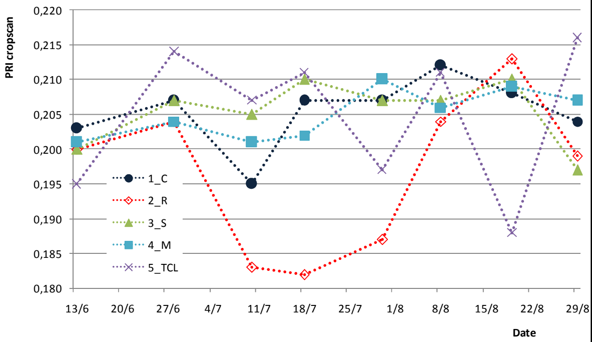
Root growth evolution



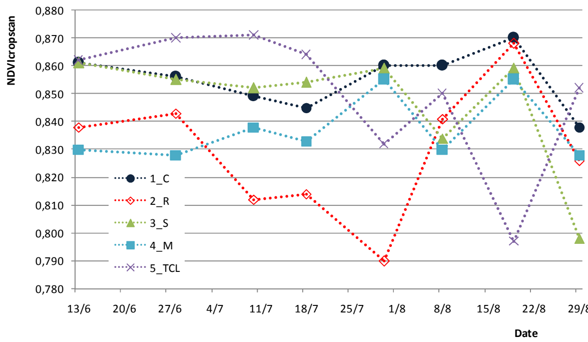
Evolution of the aerial part growth

Turfgrass quality

PRI evolution
PRIcropscan =
(R560 - R510) / (R560+ R510)



NDVI evolution
NDVIcropscan =
(R810 - R660) / (R810+ R660)



Conclusions

1. A comparison of the various treatments indicated that for the irrigation period of 2014 (from 1/5 up to 31/10/2014), the 3 smart irrigation systems (3_S, 4_M and 5_TCL), provided between 35 and 40% savings when compared to a typical theoretically calculated flat irrigation schedule.
2. The results of the rain sensor treatment (2_R) are not compared to the others as the system was off for about 15 days due to a technical problem. If for that period we assume that the system consumed the same amount of water as the 1_C reference treatment, then the savings from a rain sensor are estimated to be at least 25%.
3. Even the simple Water Budget approach (treatment 1_C) provided 20% water savings.
4. The considerable savings for treatments 3_S and 5_TCL were not accompanied by any decline in growth or quality of the turfgrass. Treatment 4_M showed no difference regarding growth and just a small difference regarding leaf area when compared to the reference treatment (1_C).

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Thank you for your attention!

Questions?

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Communication:
Technological Educational Institute of Epirus
TEIEP, i: www.teiep.gr

Laboratory of Agricultural & Environmental Engineering, i: http://hc.ioa.teiep.gr

IRMA project manager:
Dr. Tsirogiannis Yannis
Agricultural Engineer, MSc., PhD
Assistant Professor

T: +302681050249, M: +306937205322
F: 2681050240, e: itsirog@teiep.gr

IRMA financial manager:
Maretas Demetrios
Agricultural Economics, MSc.
TEIEP / Research Committee

T: +302681050034, M: +306977352064
e: dmaretas@hol.gr

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