On-Site Wireless Sensor Networks for Trees, Shrubs, Soils, and Sustainable Water Use

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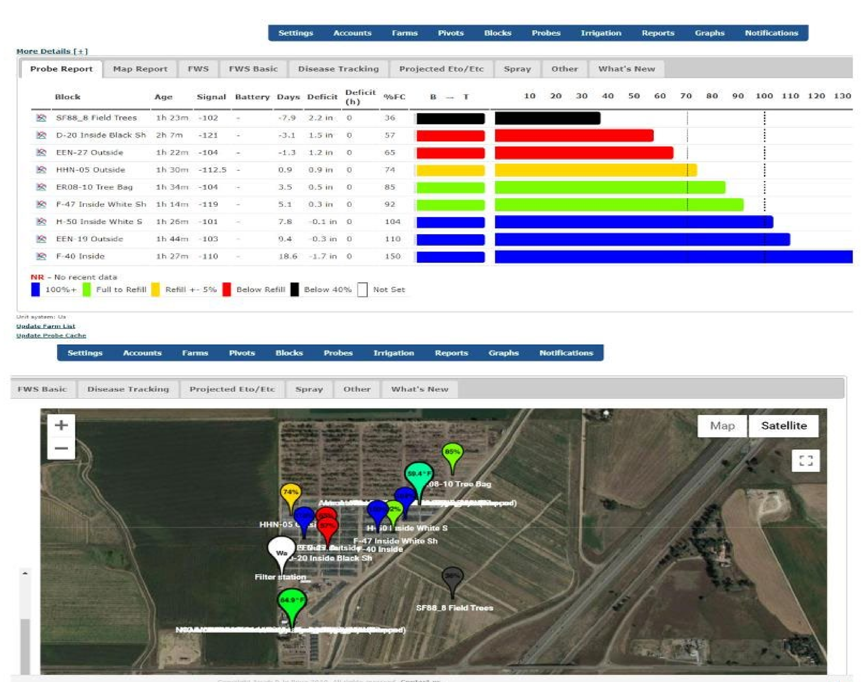
Introduction

- Global climatic anomalies and the destruction of the ecological balance have significantly affected the state of Colorado, where the scarcity of water has become a serious ecological problem with great risks due to droughts that restrict the development of agricultural production, especially in semi-desert areas.
- The main objective of this research is to identify in situ sustainable use of water, tolerance to drought for trees, shrubs, and between the different types of soils used in the nursery with wireless sensor networks in real-time to generate resilient plants and trees, with suitable soils and sustainable use of water in an artificial watershed.
- Drought in the West Impacts Water Supply, Wildfire Risk. As of July 13, 89% of the Western U.S. is in drought, with far-reaching impacts on streamflow and reservoir levels, wildfire potential, and more. And throughout the West, drought is expected to remain or develop this summer.

Objectives

- Identify in situ sustainable use of water,
- Tolerance to drought for trees, shrubs, and between the different type of soils used in the nursery with wireless sensor networks in real-time
- Generate resilient plants and trees, with suitable soils and sustainable use of water



Methodology

- The experiment was conducted in Brighton, Colorado, United States which is located in zones 5b -15 °F (-26 °C) to -10 °F (-23 °C). Köppen-Geiger climate zone: BSk- Semi-arid cold climate, ecoregion: 25d - Flat to undulating plains, heat zone 46 - 60 days at more than 86 °F (30 °C).

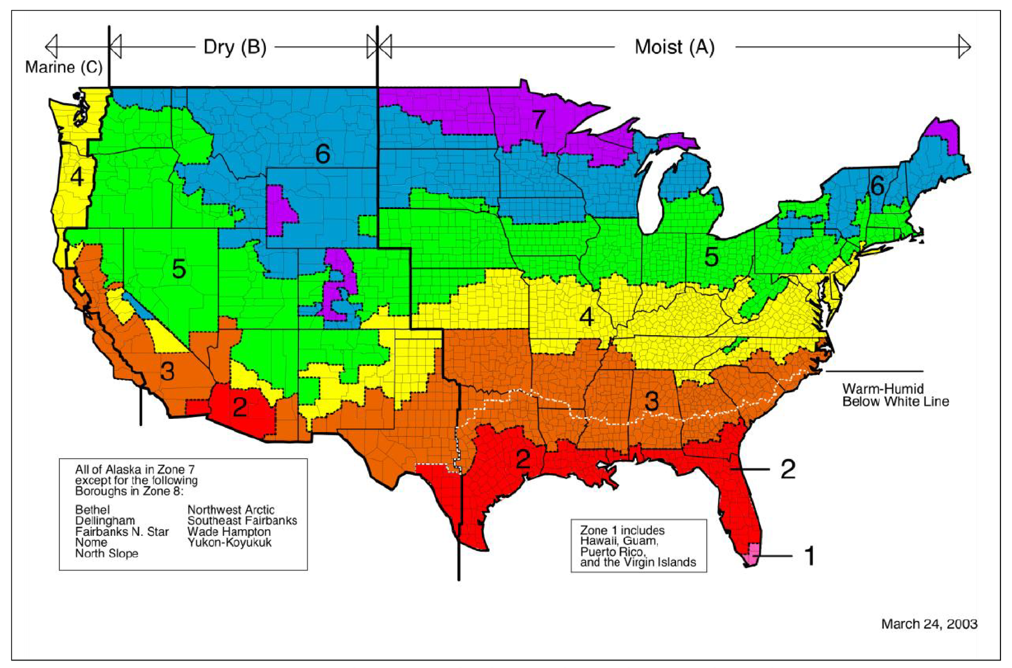
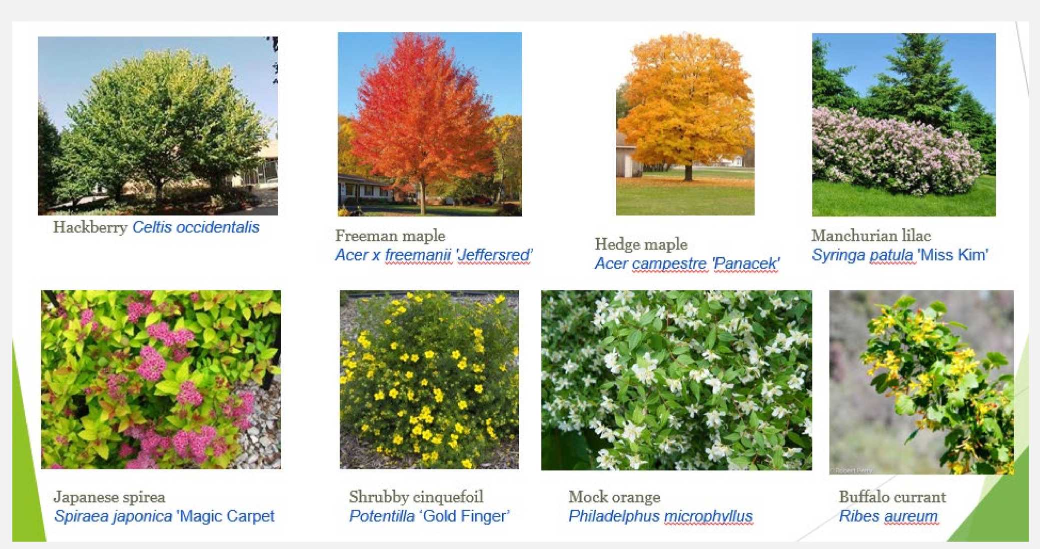


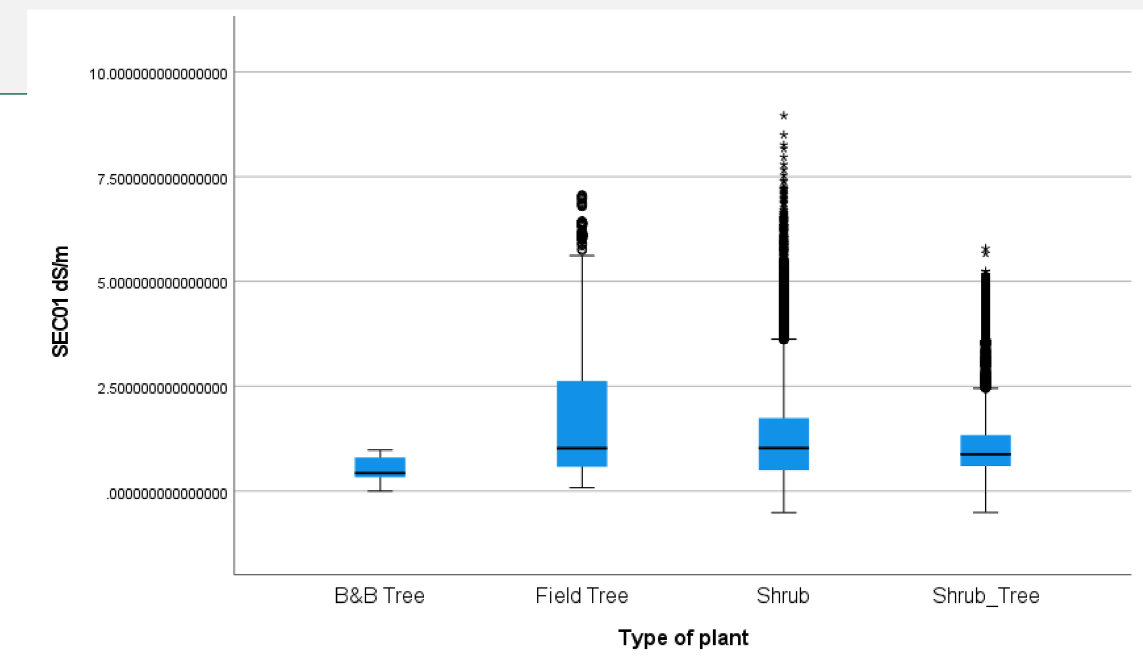
Figure 1: IECC Climate zones for the United States (Briggs et al., 2003)

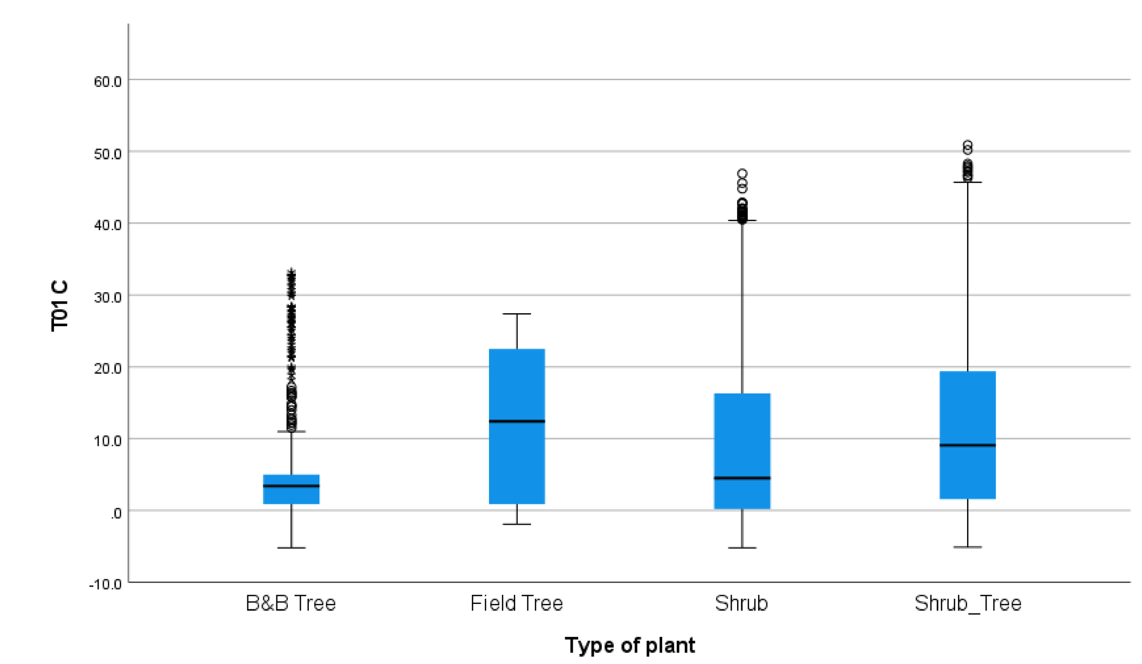
- The experimental design used was random blocks within each tunnel around the nursery and in the field.Teros 12 sensors © 2017-2021 by METER Group, Inc. USA, which measure the temperature, soil moisture, and electrical conductivity in bulk connected with LSMP - LoRa Professional Multipurpose Telemetry Station and Probe Schedule software.The sensors were located in the field, containers, and trees healed in ball and burlap (B&B)

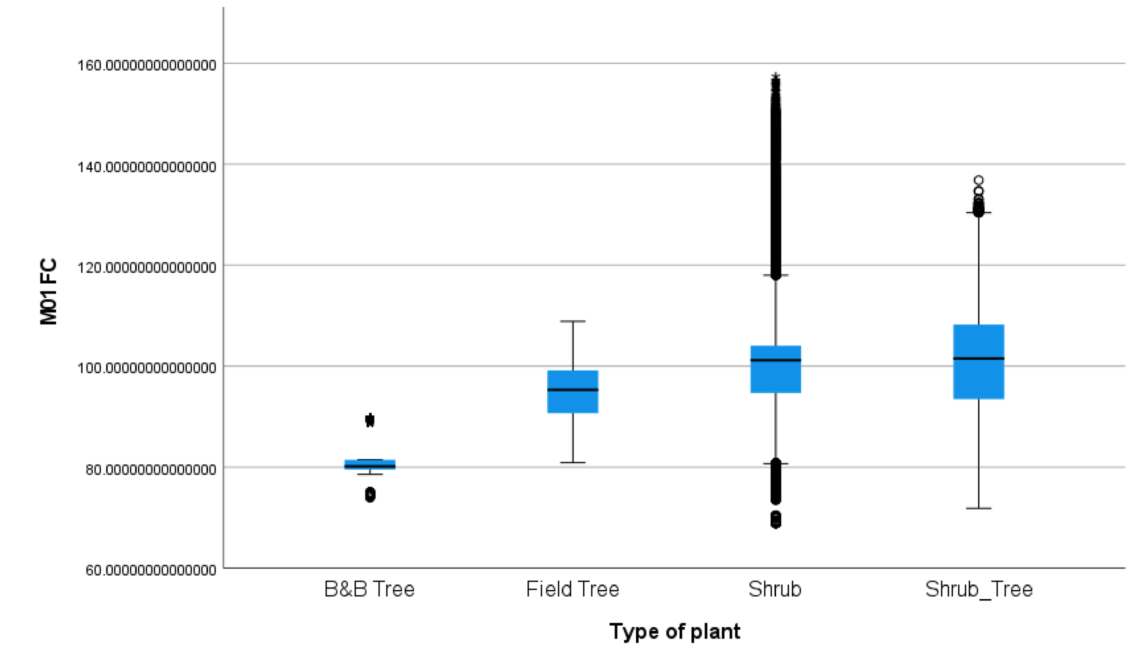


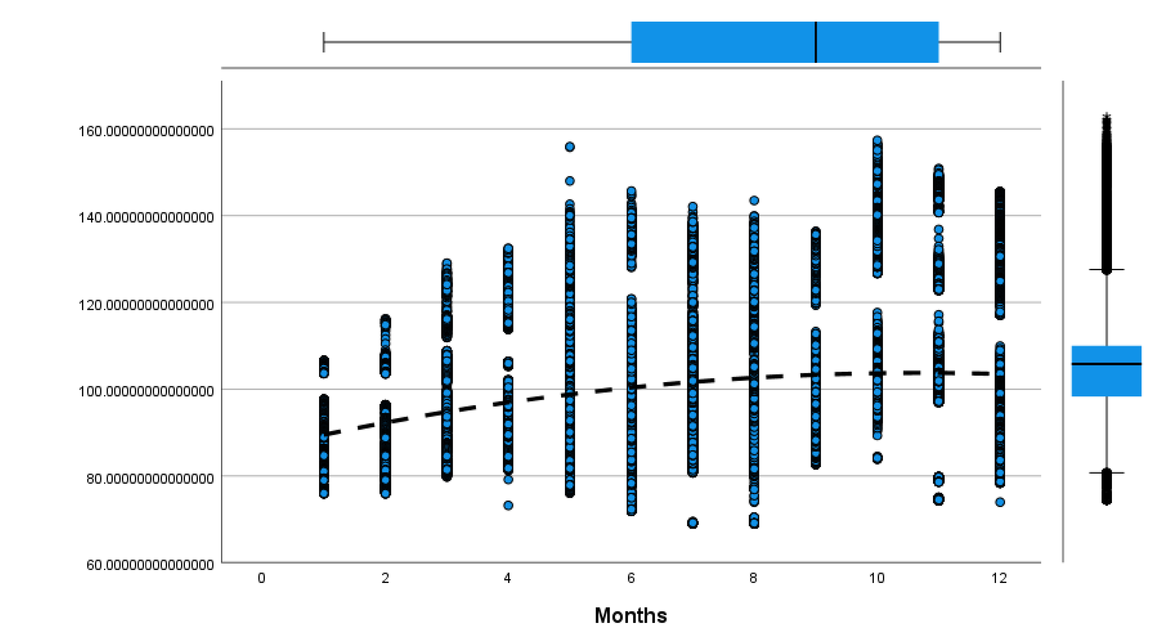
Results and discussion

- Each species of tree and shrub has certain requirements:
- Cultivation (Water, Soil Conditions, Sunlight/Shade Levels, Growth Space); Environmental (Rusticity and heat, Pollution levels, Humidity, Drought tolerance, Resistance to pests and diseases) Design (Growth rate, Size at maturity, Habit and growth shape, Type and color of leaves, flowers, and fruits, Sensitivity of wood).
- Highly significant differences were found between electrical conductivity, temperature, and soil moisture levels depending on the type of plant for trees in the field, shrubs in containers, and trees in B&B.









Conclusions

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
M01 FC * Type of plant	Between Groups	(Combined)	1859941.087	3	619980.362	3056.325	.000
	Within Groups		24625373.511	121396	202.852		
	Total		26485314.599	121399			
SEC01 dS/m * Type of plant	Between Groups	(Combined)	4874.744	3	1624.915	1541.651	.000
	Within Groups		127952.558	121396	1.054		
	Total		132827.302	121399			
T01 C * Type of plant	Between Groups	(Combined)	390831.082	3	130277.027	1360.652	.000
	Within Groups		11623184.264	121396	95.746		
	Total		12014015.346	121399			
VWC Soilless cm * Type of plant	Between Groups	(Combined)	808429.710	3	269476.570	4264.780	.000
	Within Groups		7670590.384	121396	63.187		
	Total		8479020.094	121399			
VWC Mineral cm * Type of plant	Between Groups	(Combined)	864400.646	3	288133.549	3427.072	.000
	Within Groups		10206456.363	121396	84.076		
	Total		11070857.009	121399			

- Highly significant differences were found between electrical conductivity, temperature, and soil moisture levels depending on the type of plant for trees in the field, shrubs in containers, and trees in B&B.

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