Internet of Things (IoT)-based Precision Irrigation with LoRaWAN Technology Applied to High Tunnel Vegetable Production

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Introduction

- Agriculture consumes approximately 80% of water use in the United States
- As the global population increases, crop production is expected to increase while water resources are increasingly limited

Introduction

- Conventionally, irrigation based on experiences causes inefficient water usage and crop yield and quality reduction.
- Precision irrigation: Applying only the necessary amount of water directly to the crop
- Lower cost of irrigation water and manpower, and improvement of crop yield and quality
- Based on Evapotranspiration (ET)/crop water stress/soil moisture
- Soil water content: water volume/soil volume
- Soil water potential: capability soil holds water

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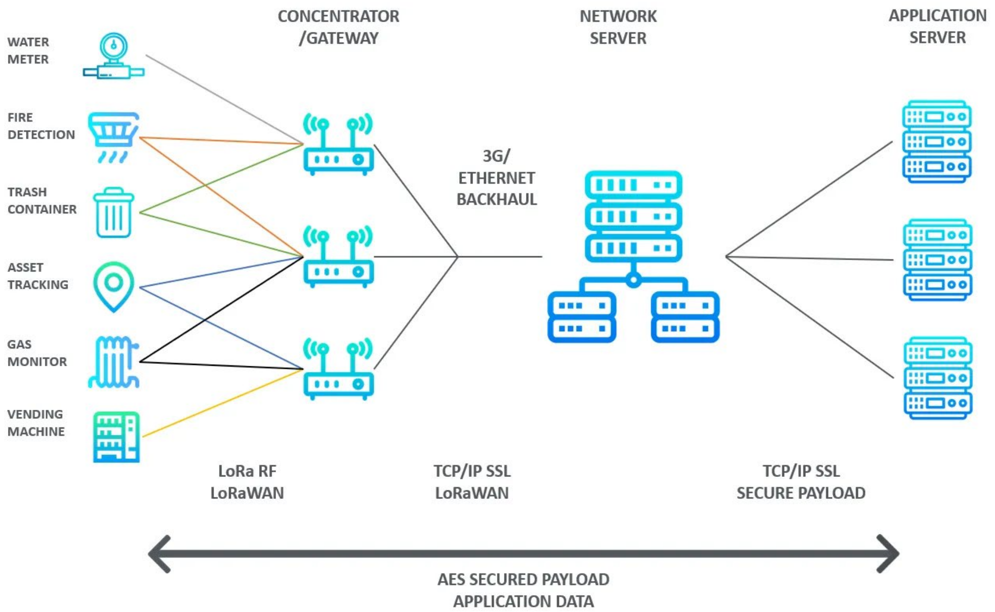
Introduction

- IoT system
- Uploading sensor data to the Internet.
- Analyzing sensor data and controlling irrigation on the Internet
- Various network types used in IoT-based irrigation: Wi-Fi, Bluetooth, ZigBee, Sigfox, cellular network (GPRS, EDGE, LTE), LoRaWAN



Source: https://tekzitel.com/what-is-lorawan/

Technology	Network type	Frequency	Range	Data rate	Power	Security
LoRaWAN	LPWAN	915 MHz	10 km	0.3-50 kbps	10mW	AES 128 bit
LTE	GERAN/UTRAN	700-2600 MHz	10 km	0.1-1 Gbps	1 W	3GPP 128-256 bit
Wi-Fi	WLAN	2.4, 3.6, 5 GHz	100 m	6-780 Mbps	1 W	WEP, WPA, WPA2

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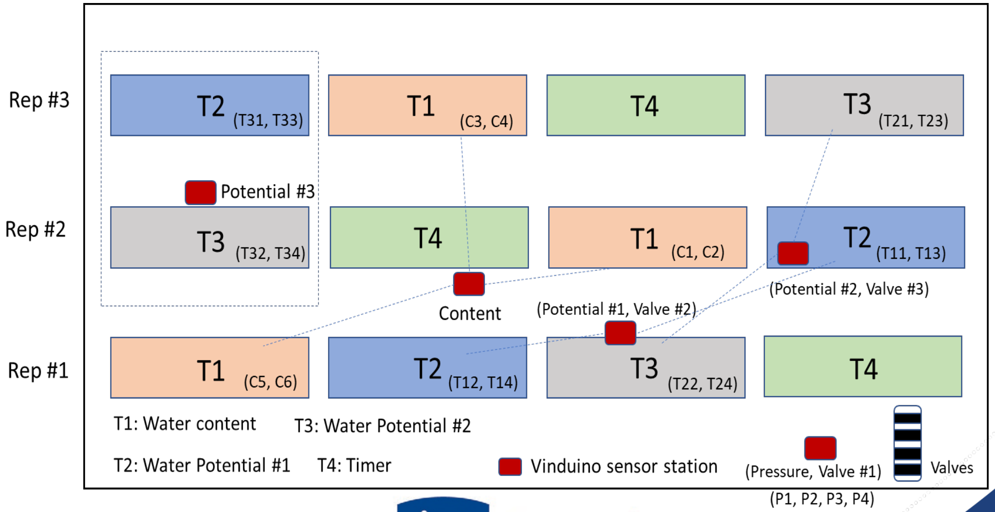
Objectives

- Investigating the applicability of soil water content and soil water potential sensors in the developed irrigation system

- Conducting functionality evaluation on the irrigation system in terms of data communication and irrigation execution

Method: Experimental Setup

- Red cabbage (*Brassica oleracea* cultivar Omero F1)
- T1: Soil water content
- T2: Soil water potential #1 (-30 kPa)
- T3: Soil water potential #2 (-60 kPa)
- T4: Timer
- 3 replicates
- 2 depths (15 cm, 30 cm)



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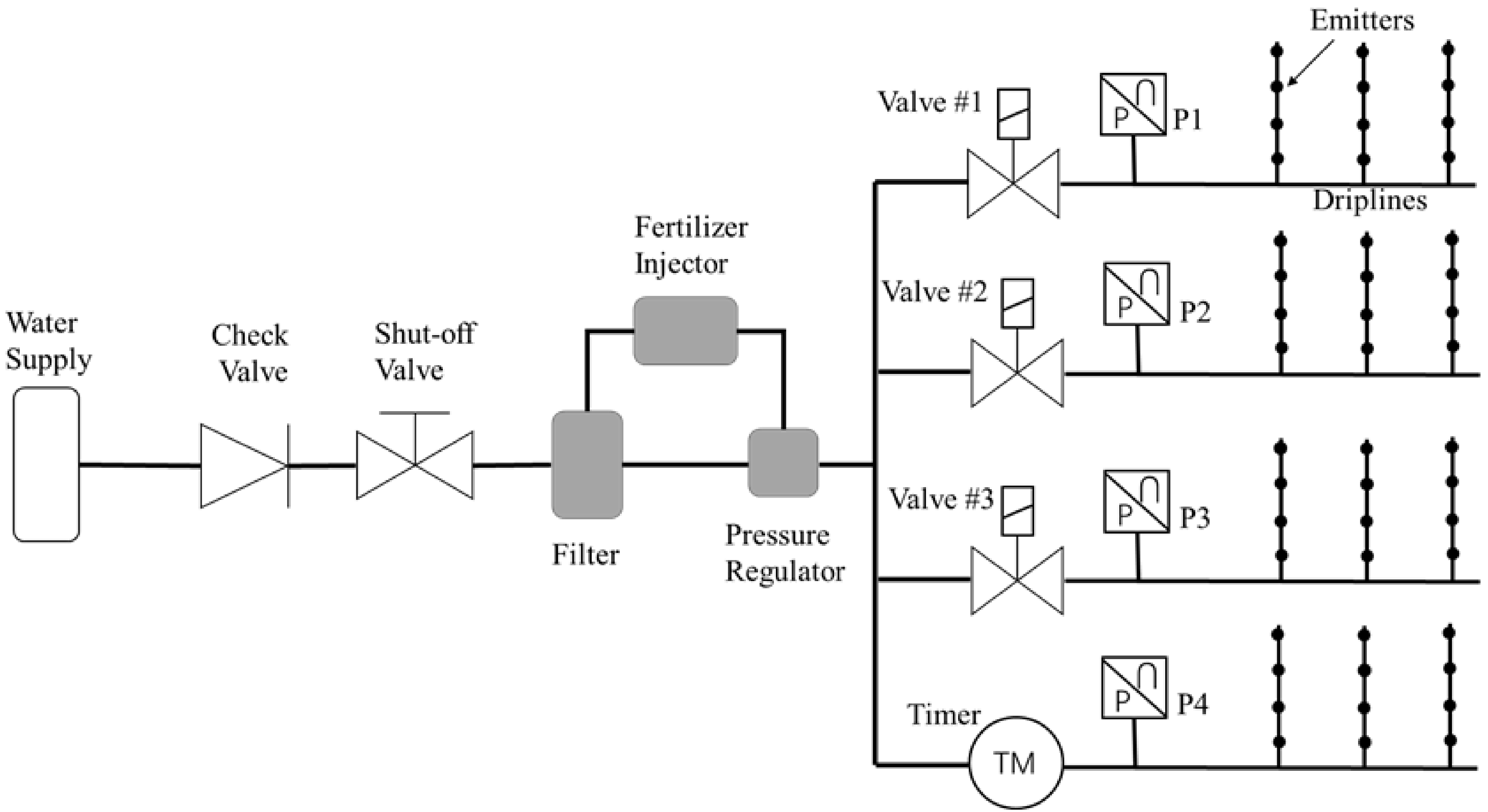
Method: Irrigation system



Method: Sensor system

- 6 soil water content sensors
- TEROS 10, METER Group, Inc., Pullman, WA

12 soil water potential sensors
Watermark 200SS-5, Irrometer company, Inc., Riverside, CA

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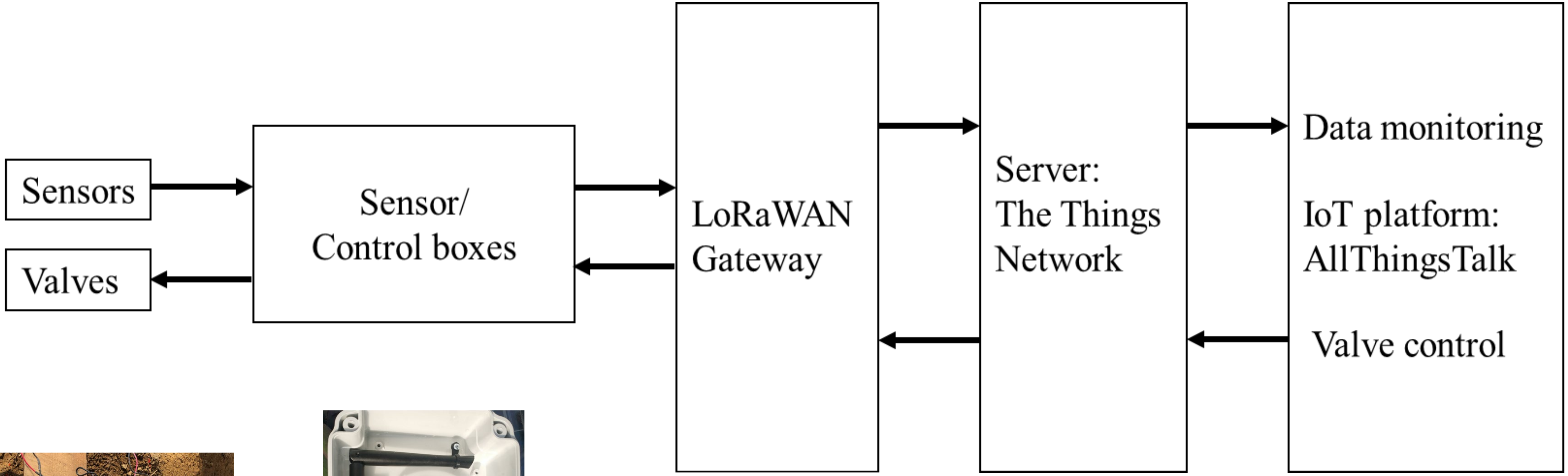
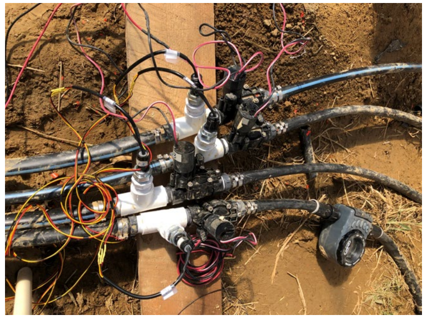
Method: IoT system





THE THINGS NETWORK

AllThingsTalk by ALSO

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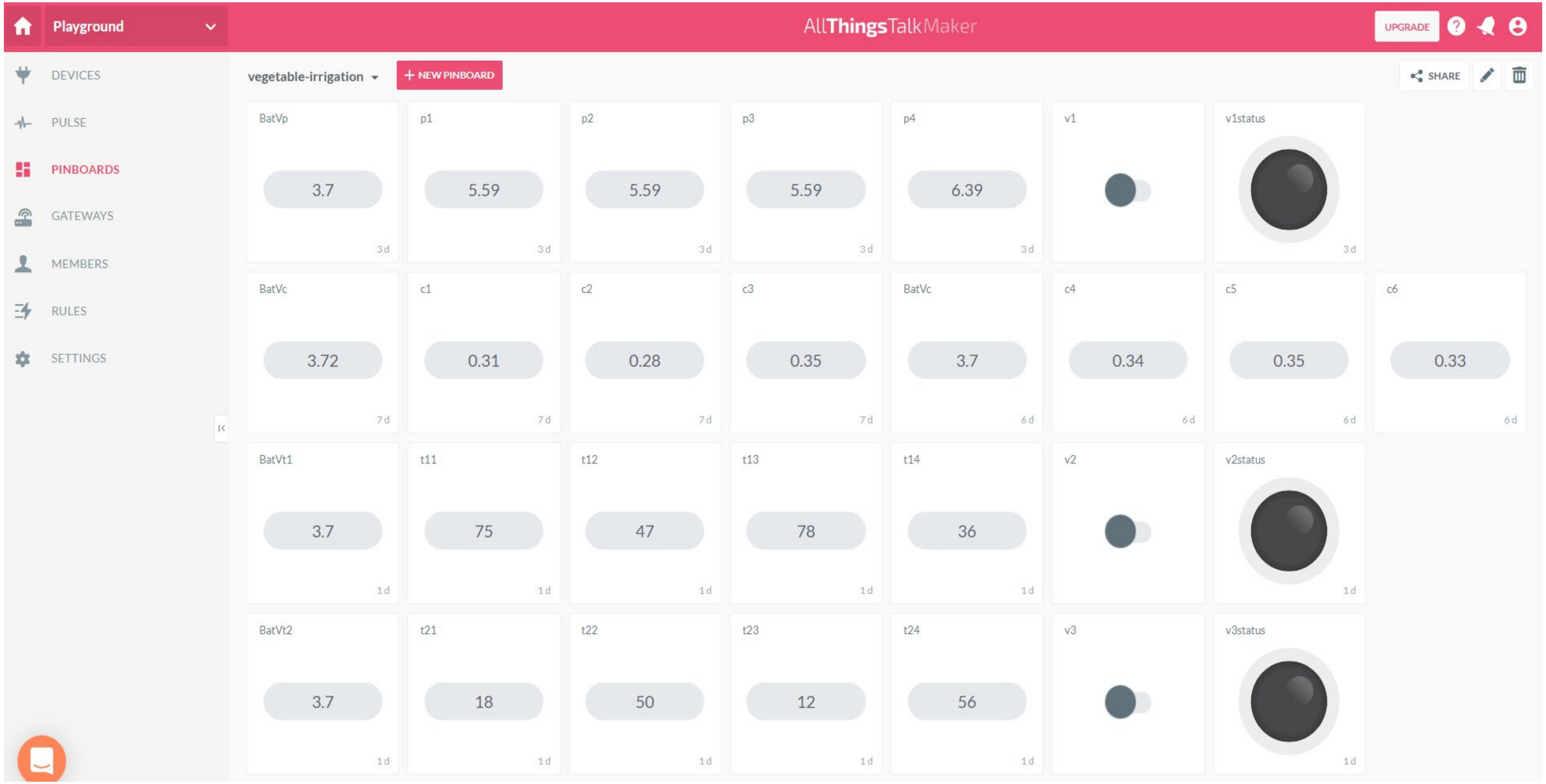
Method: IoT system



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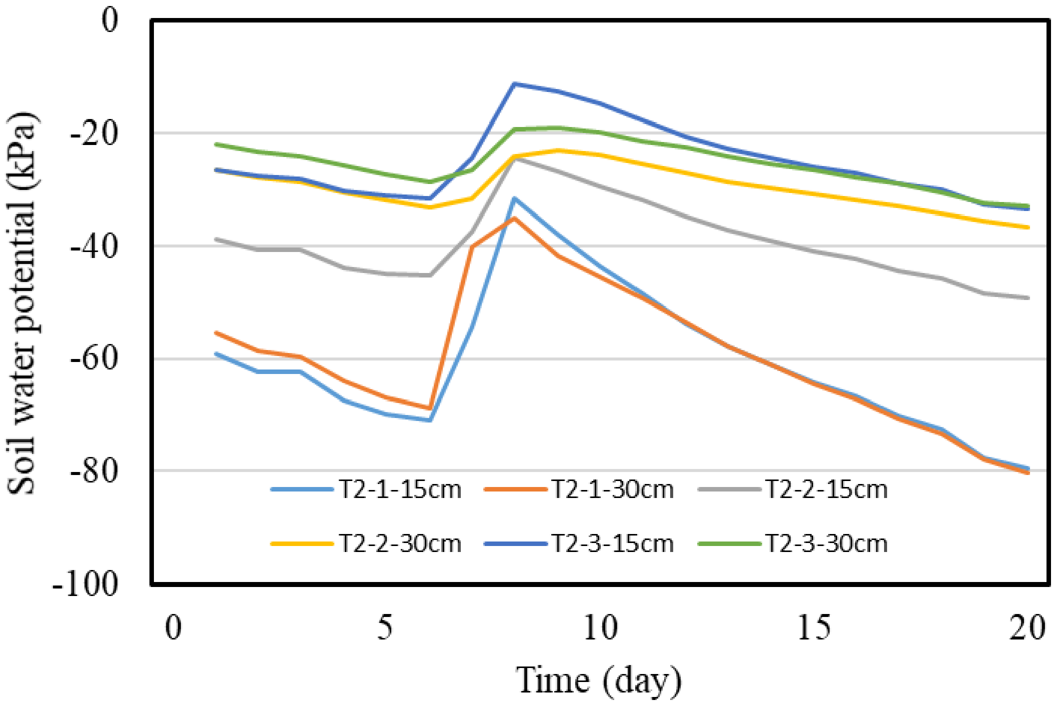
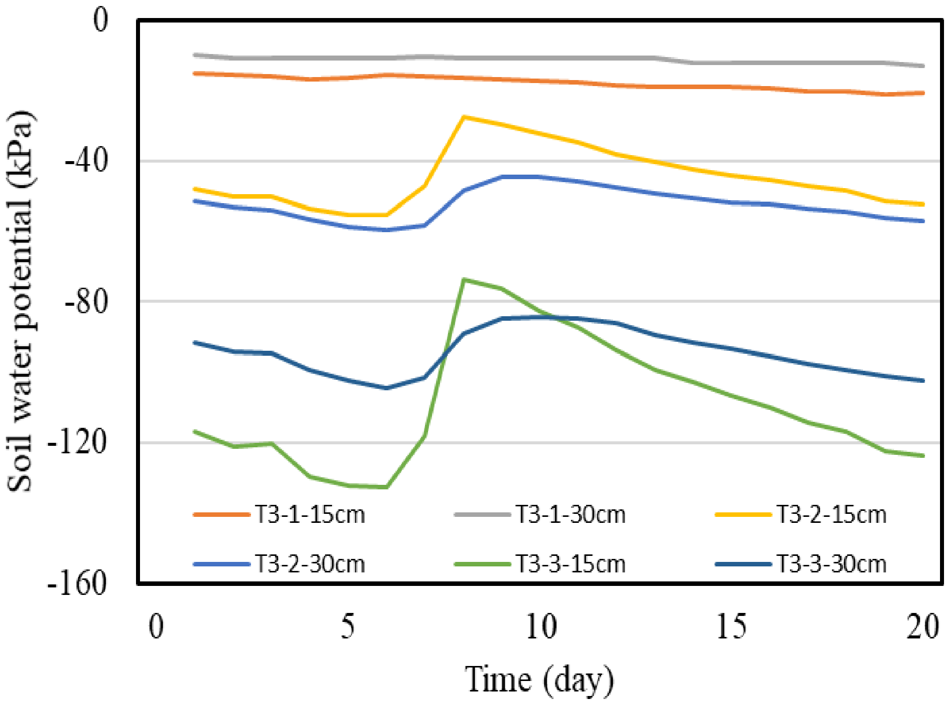
Results: Feasibility of the IoT system

- 300 m between high tunnel and gateway
- 4.3 % signal loss
- Control the valve on the IoT platform
- Batteries work for 2 months with a solar panel
- More battery consumption for soil water content sensors because of continuous power supply

Results: Soil moisture monitoring with IoT system

- Data record from 11/20/19. Irrigation on Day 6 11:50 AM
- Soil water potential (T2&T3) day 1-20





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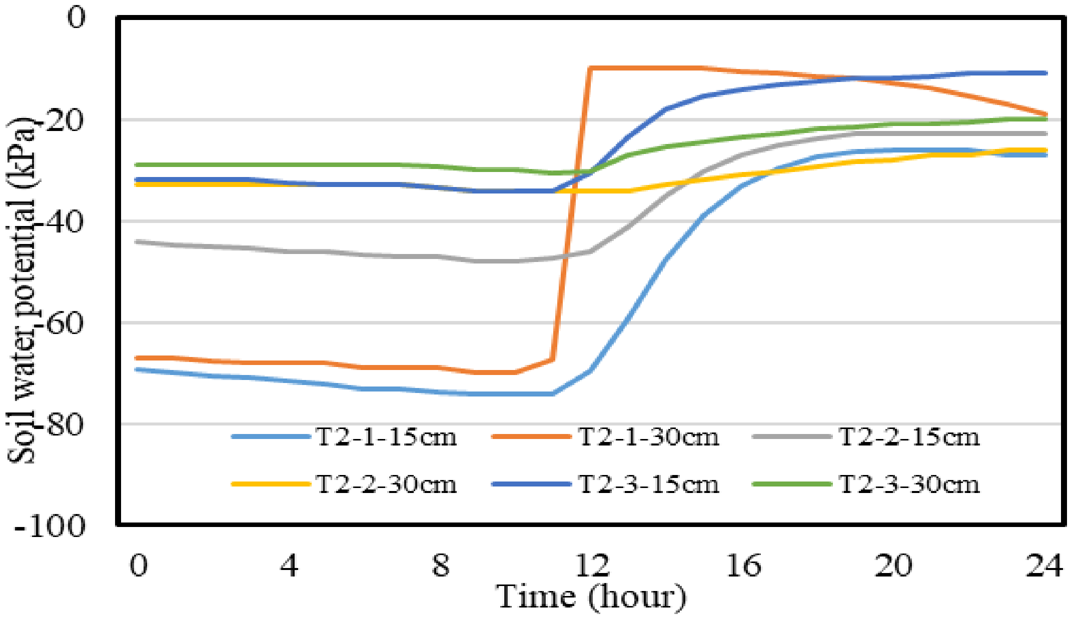
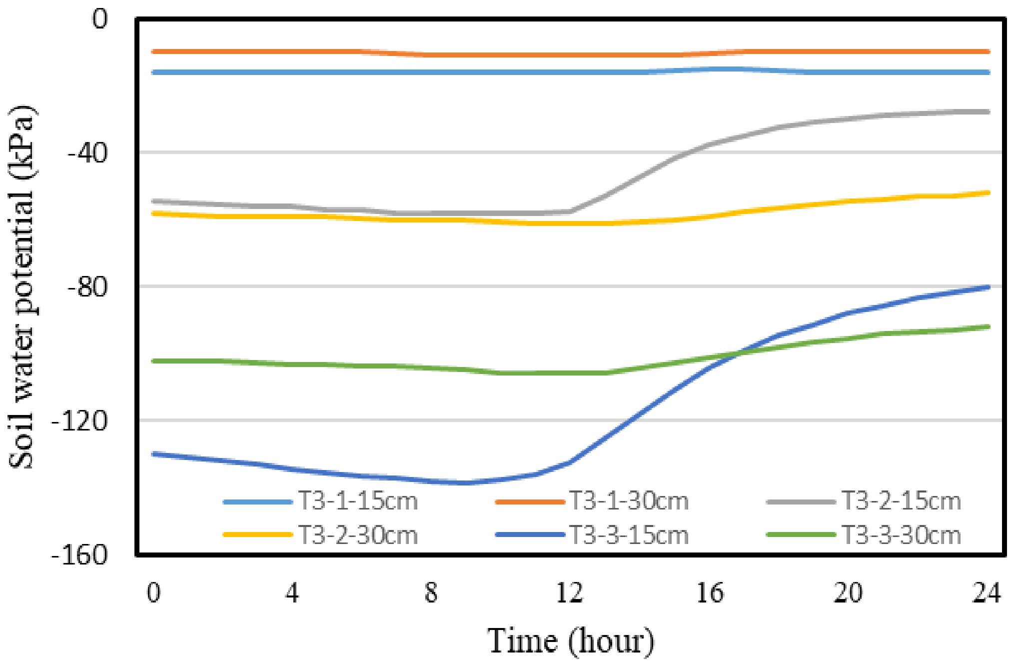
Results: Soil moisture monitoring with IoT system

- Data record from 11/20/19. Irrigation on Day 6 11:50 AM
- Soil water potential (T2&T3) 0–24 h on Day 6





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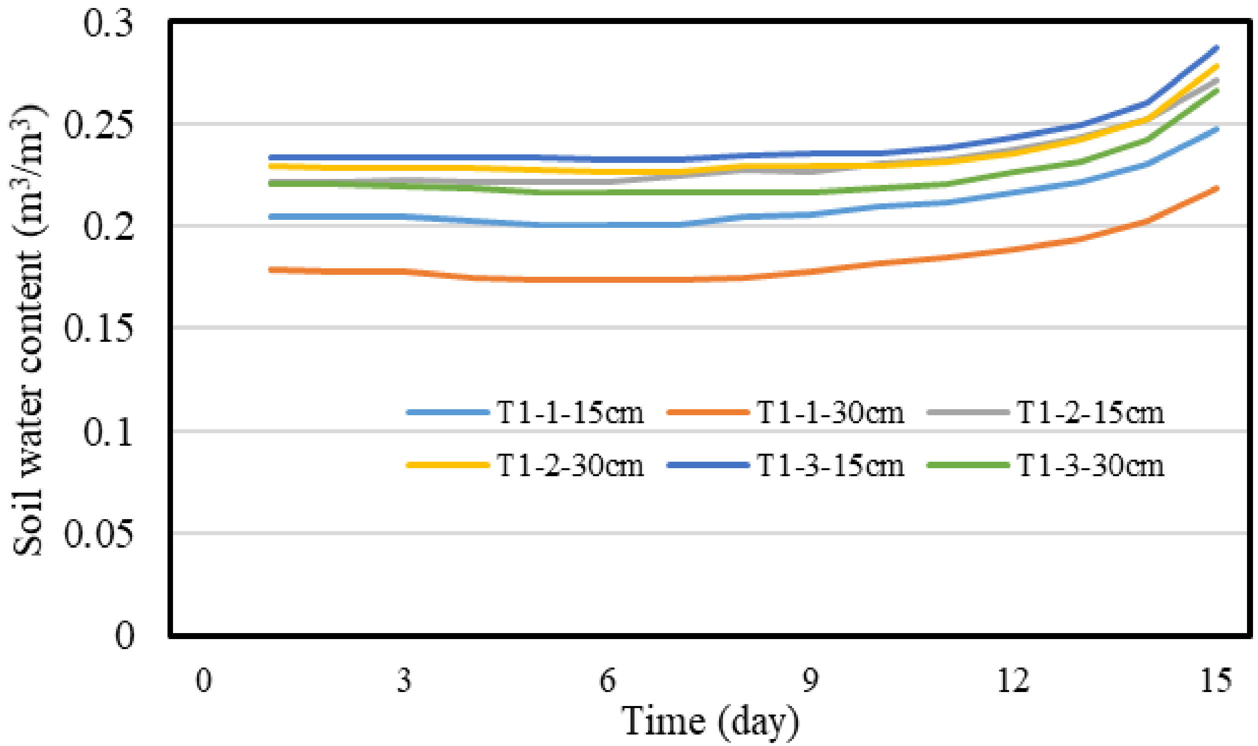
Results: Soil moisture monitoring with IoT system

- Data record from 11/20/19. Irrigation on Day 6 11:50 AM
- Soil water content (T1) day 1-15



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Conclusion

- The IoT system worked well in general.
- 4.3% signal loss with 300 m distance. Caused by the office wall obstacle, long distance, and gateway performance.
- Enough batteries for two months
- Issues on soil water content sensors

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Thank you!

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