LoRaWAN for Wildfire Prediction and Prevention
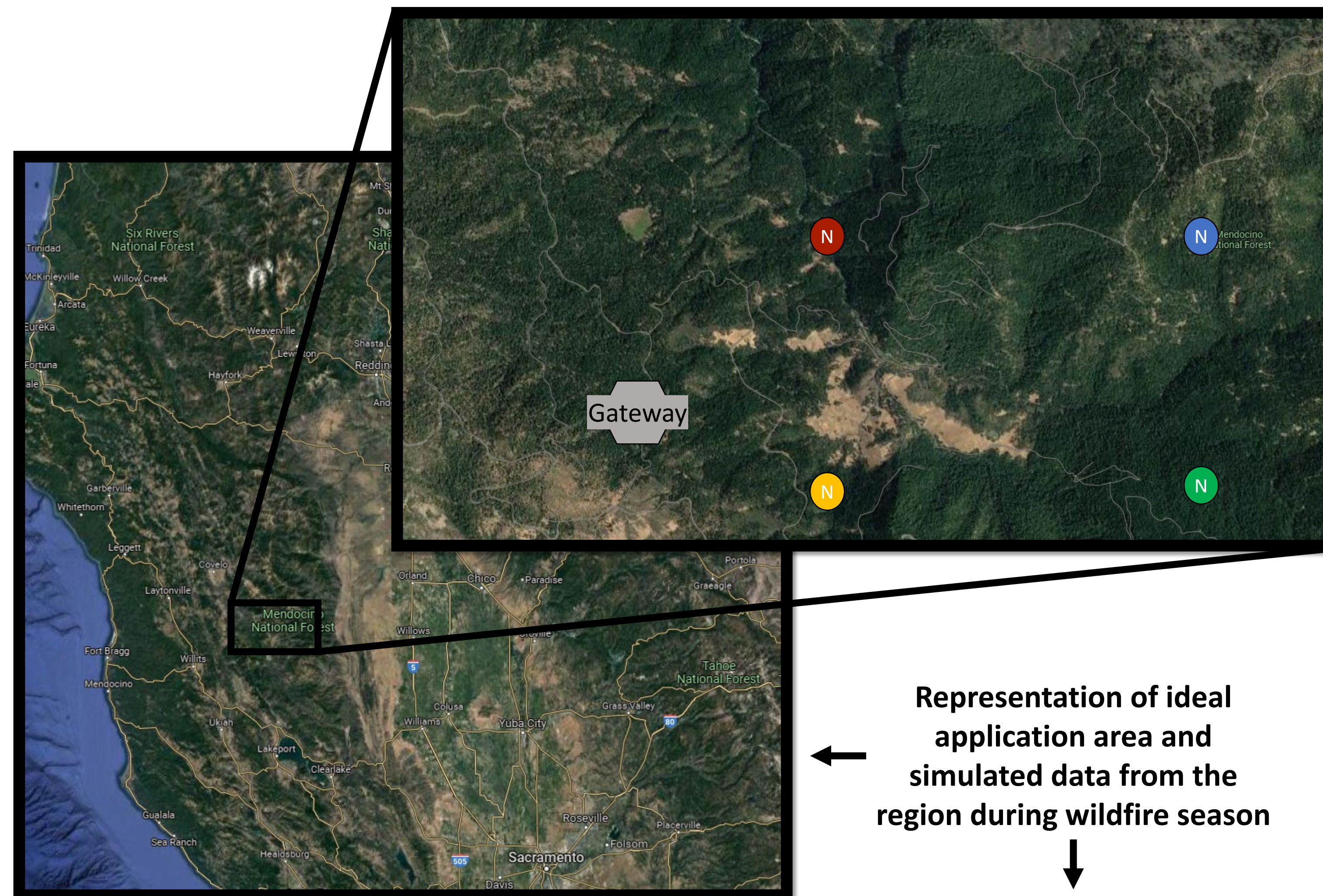
QR Code for GitHub

Background

- Massive uncontrolled wildfires, have become more common especially in the western United States have long ranging and extremely detrimental effects
  - Wildfire occurrences have doubled from 1984-2015
  - 84% of wildfires are caused by human activity, from negligence to faulty equipment.
  - The wildfires in California in 2018 alone have estimated cost of $150 billion
    - Additional costs:
      -To health due to poor air quality
      -Environment due to carbon emissions
      -And psychosocial impacts

Objective

- Build a proof-of-concept IoT system of low-power, low-cost sensor nodes which measure temperature and relative humidity data from hard-to-reach areas.
- Use this data to refine remote sensing data in order to improve the accuracy of existing wildfire prediction models.
- More accurate data will allow decision makers and stakeholders, prepare and allocate resources more efficiently, to prevent catastrophic wildfire losses.
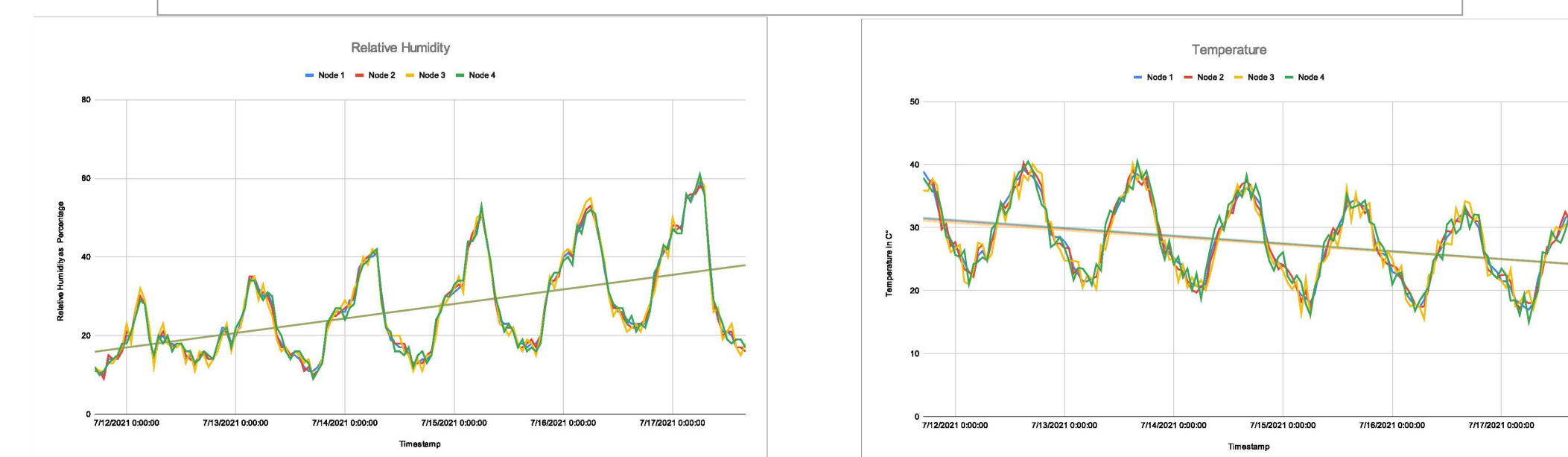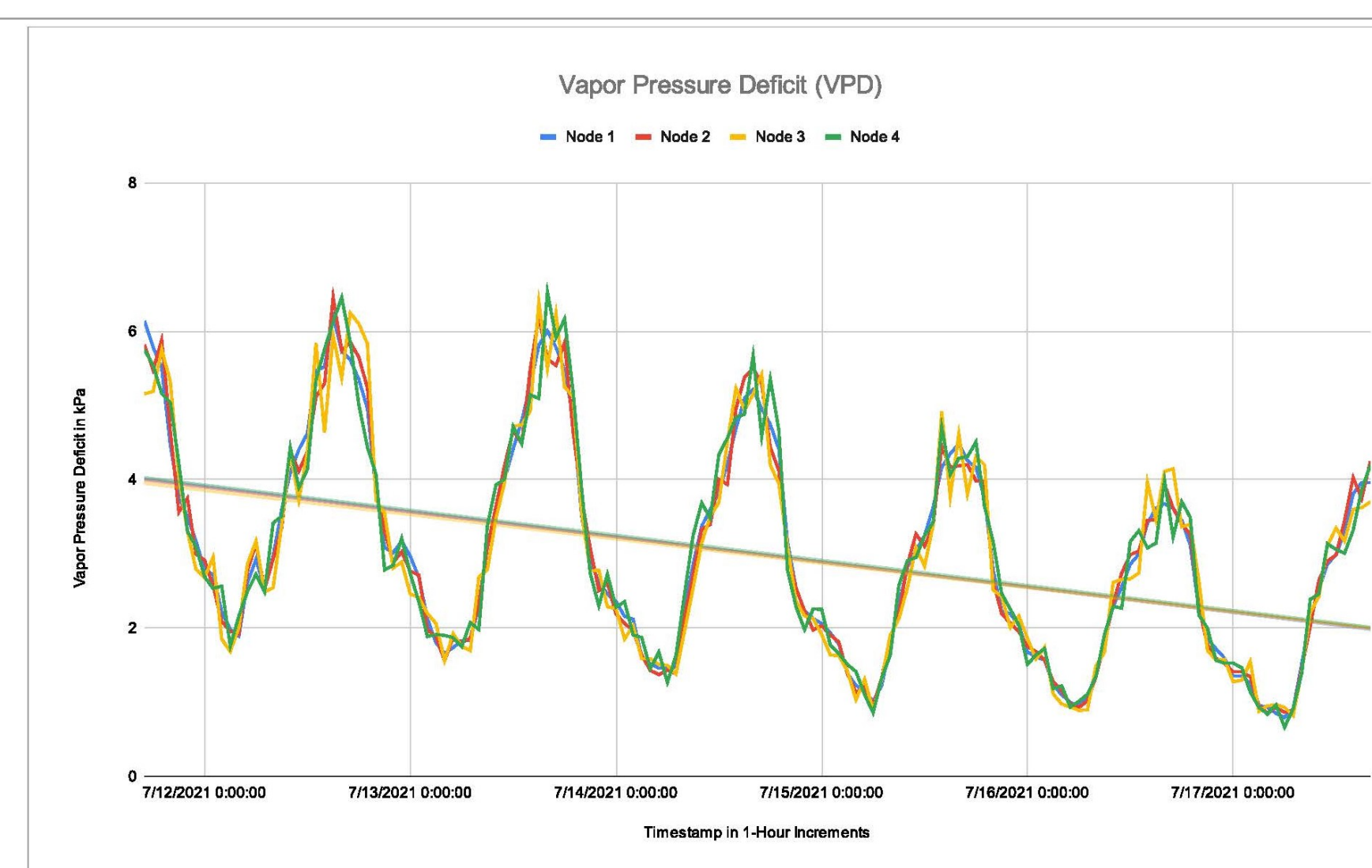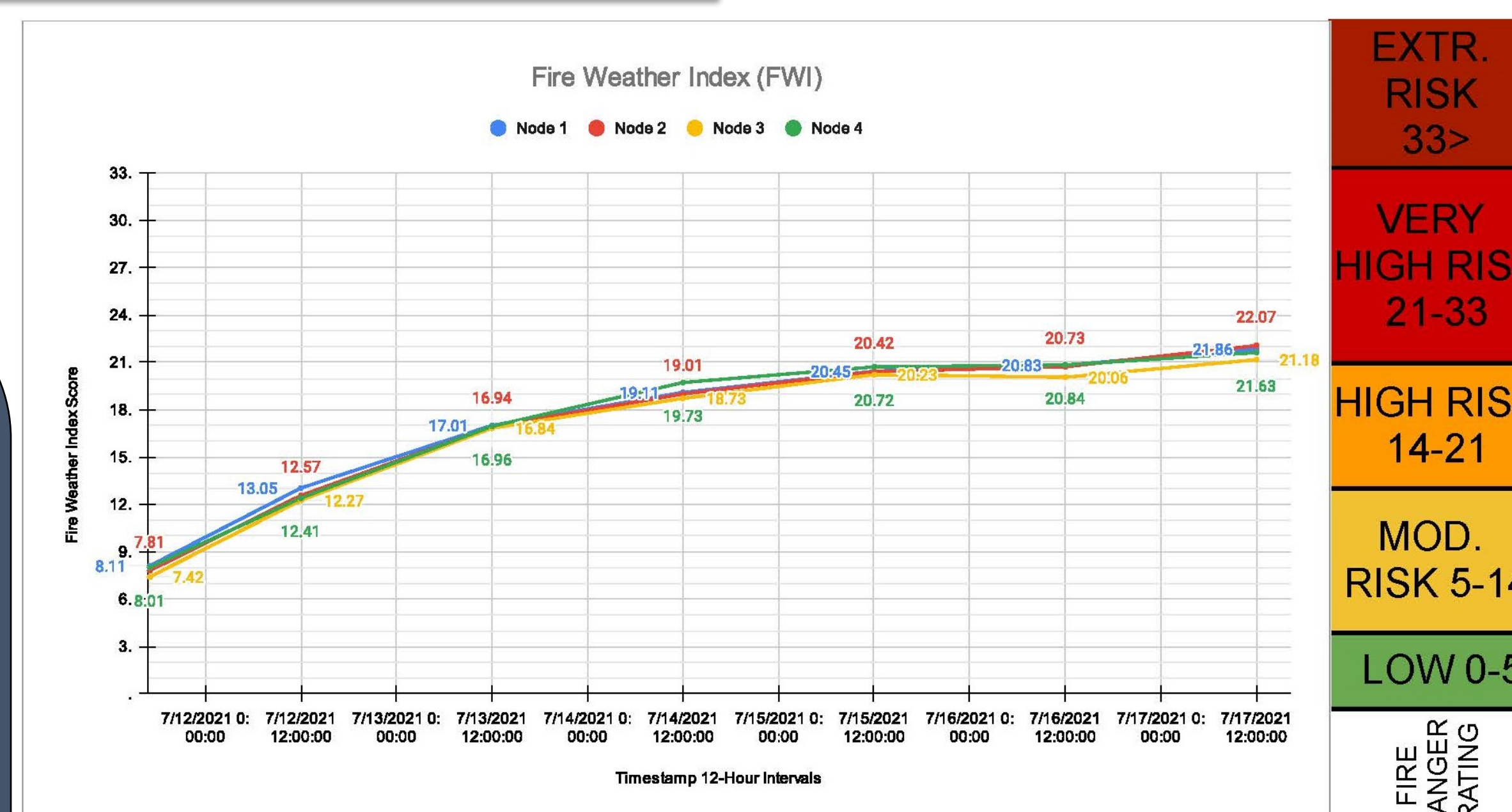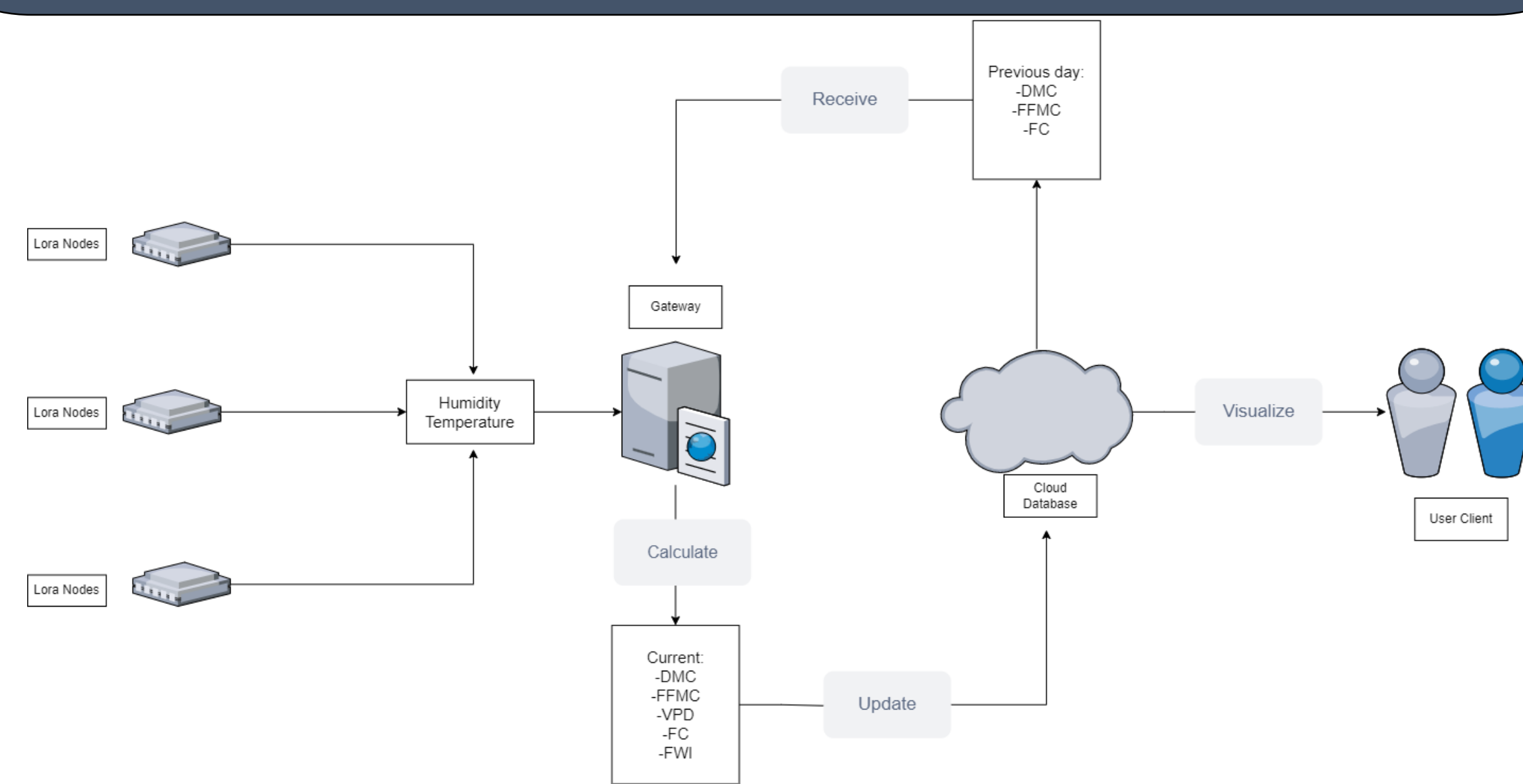
Representation of ideal application area and simulated data from the region during wildfire season

Fire Weather Index (FWI)

FIRE DANGER RATING	
EXTR. RISK 33>	
VERY HIGH RISK 21-33	
HIGH RISK 14-21	
MOD. RISK 5-14	
LOW 0-5	

Vapor Pressure Deficit (VPD)

Relative Humidity

Temperature

Simulated Data from Potential Target Implementation Area: Mendocino, California 07/11/21-07/14/21

Methodology

- Distributed sensor nodes transmit temperature and humidity data at 1-hour intervals
- Gateway receives data from nodes, uploads it to Adafruit.io (AF.io), then calculates and uploads:
  - The Vapor Pressure Deficit - hourly
  - The Fire Weather Index (FWI), and it's components - once daily:
    - The Fine Fuel Moisture Code (FFMC)
    - The Duff Moisture Code (DMC)
    - The Drought Code (DC)
    - Previous 24-hour precipitation total and the wind speed is gathered from the hourly weatherbit.io API
  - Retrieves the FFMC, DMC and DC from the previous day from Adafruit.io for calculation
- The data is then displayed on the AF.io Dashboard

Results

Hardware - Developed:

- Three battery powered Sensor Nodes
  - Raspberry Pi Zero, LoRa transceiver module and AM2302 sensor module
- LoRa Gateway
  - Raspberry Pi 3B+ and LoRa transceiver module

Software – Developed Python Code:

- For LoRa based data transmission protocol
- To retrieve weather station data from weatherbit.io API
- Calculate wildfire prediction indices and metrics
- Automated uploads of data and metrics to cloud database (AF.io)

Future Directions

- Deploy nodes to rural, wildfire prone areas
- Create real-time visualizations of data based on GPS coordinates on map
- Compare against remote sensing data to refine the accuracy of prediction models