WATER-WISE GREEN LANDSCAPES OF UW WITH SENSORS AND SATELLITES

CIVIL & ENVIRONMENTAL ENGINEERING

FACILITIES SERVICES
UNIVERSITY of WASHINGTON

Project Overview

Motivation: We seek to reduce overwatering and improve field decision-making to support UW's sustainability goals.

Our project builds on a 2023-24 pilot project combining soil moisture sensors and satellite data to monitor UW campus irrigation.

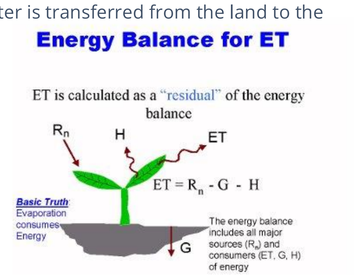
Our primary deliverables were:

- Evaluate system performance during Summer '24.
- Develop a mobile app to provide UW Facilities staff with real-time irrigation insights.
- Provide a framework for other campuses and organizations to implement the system.

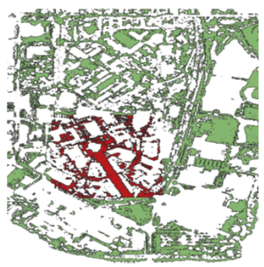
Impact Analysis Overview

We conducted a pseudo-analysis of the sensor/satellite system created by 2023-2024 pilot project (sD.R.I.P.S-sense) throughout the Summer of 2024.

- Mathematical Modeling Terms:
  - Penman-Monteith Equation: Crop water demand (derives data from sensors).
  - SEBAL (Surface Energy Balance Algorithm for Land): Observed water consumed by plants (derives information primarily from satellites).
  - Evapotranspiration (ET): process by which water is transferred from the land to the atmosphere.
- Mathematical Equations:
  - SEBAL: $ET = R_n - G - H$
  - Penman: $$ET_o = \frac{0.408\Delta(R_n - G) + \gamma\frac{900}{T+273}u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$
  - ET: latent heat flux (W/m^2)
  - R_n: net radiation flux at the surface
  - G: soil heat flux
  - H: sensible heat flux



Pseudo-Analysis Findings

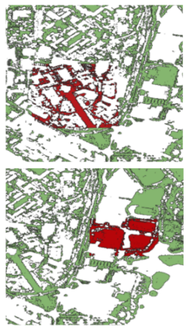


Sensor (Rainier Vista Region):

- Area lacks irrigation and ET data making it a desired study region
- The red highlighted region experienced an average surplus (overwatering) of **47.28%** per week
  - Area: **17.60 acres**
  - *Potential* Savings per week: **$3,160**
  - *Potential* Summer Savings: **$34,762**

Pseudo-Analysis Findings

The system helps UW Facilities save time and reduce costs while maintaining grass and vegetation, though its accuracy could be improved with additional sensors.



Sensored Region (Rainier Vista Region):

- Average % Deficit: 47.28% per week
- Likely realistic and actionable information

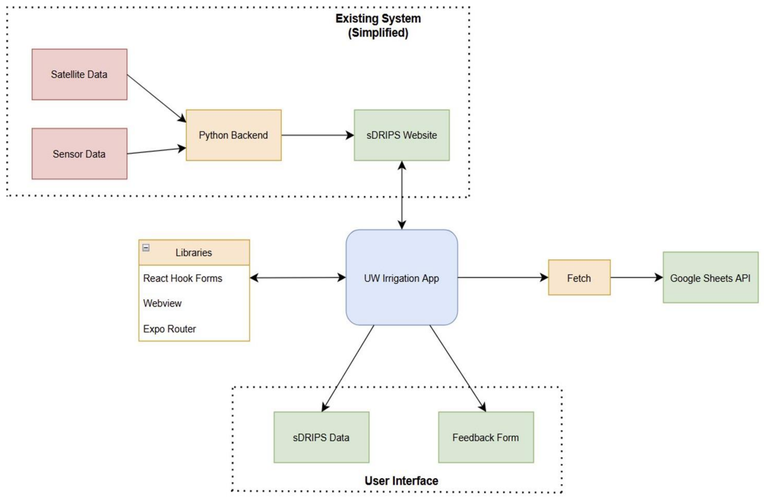
Non-Sensored Region (IMA Fields Region):

- Average % Deficit: 115.00% per week
- Likely highly uncertain information but still potentially actionable if applied with caution
- Further away from sensors mean higher uncertainty

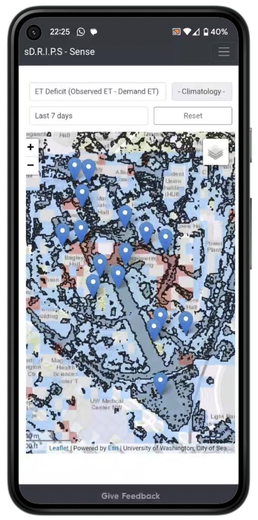
App Development Overview

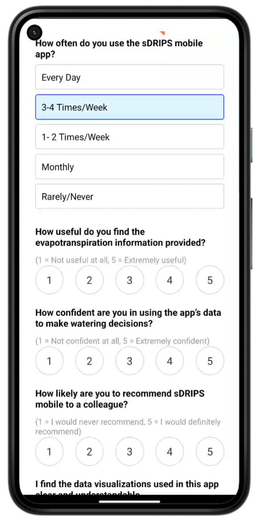
We wanted to create an easy-to-use mobile app that UW Facilities staff would find helpful and intuitive.

- Built with React Native to quickly prototype a shared Android and iOS app from a single codebase.
- Leveraged the existing sD.R.I.P.S-sense backend, since lightweight solutions for displaying GeoTIFFs in mobile apps are limited.
- Integrated with the free Google Sheets API to automatically store user feedback in a cloud-based spreadsheet.
- Designed the app to be low-maintenance, with a simple codebase that future capstone teams can easily understand and build upon.



App Features and UI





- Map displaying evapotranspiration (ET) deficit over the past 7 days, with geolocation features automatically zooming into the user's current location.
- Options to display climatology and grass water demand data.
- Feedback form to gain insights from users about app ease-of-use and information accuracy.

- **Deficit = Actual ET – Demand ET**
- **Deficit ≈ Actual Watering – Required Watering**
- **Red: under-watering (Deficit is negative)**
- **Blue: over-watering (Deficit is positive)**

Scan to download the app

Future Work

- Complete beta testing of our Android app to be eligible to publish to the Google Play Store.
- Create an implementation package for other universities to create similar systems and improve their own irrigation efficiency.
- Expand sensor network across UW campus.

Acknowledgements

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