

The Dionysus Project: Monitoring in Vineyards with Satellite Remote Sensing

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1) Introduction

Managing vineyards varies by region and farmers need to stress the grapevines in order to produce quality grapes for quality wine. Soil moisture is a critical component when it comes to vegetation and the health of these vineyards, soil moisture deficit can lead to drought along with vegetation stress if not correctly managed.

Satellite images allows us to view vineyards while sending us data from a distance because vineyards are large and walking through the fields to get data is impractical. Since remote sensing provides us with images covering large areas of land, it allows us to view the grapevine conditions.

Some useful measurements derived from satellites are the Normalized Difference Vegetation Index (NDVI), which uses the difference of the red (0.636um-0.673um) and near-infrared (0.851um-0.879um) bands and the sum of these values. Normalized Difference Water Index (NDWI) is calculated as a ratio between the short-wave infrared (1.566um-1.651um) and near-infrared(0.851um-0.879um) and the sums of these values. The satellites give us this information on the NDVI and the NDWI state of the grapevines which can be used to assess the relationship with soil moisture and growing conditions.

2) Background

NDVI indicates how healthy or unhealthy large areas of grass/crops grow. NDWI indicates the amount of water in a canopy. NDVI values range from +1.0 to -1.0. Areas with sand, or snow usually show very low NDVI values that range from 0.1 or less. While tropical forest or crops have high NDVI values ranging usually from 0.6 to 0.9. NDWI values range from -1 to +0.5, -1 and below means the water content is low and anything above +0.5 has a high amount of water. Researchers can use satellite data and turn it into NDVI and NDWI values to create images and rough sketches of vegetation type and conditions.

3) Objectives and Motivation for Study

The goals of this research were to:

1. Improve our understanding of remote sensing observations that monitor vineyards.
2. Compare field data to satellite data in order to verify that the satellites are measuring the growth of the vineyards.

Relating to the vineyards, the beginning of the season is expected to have higher NDWI measurements and then as the season goes on the NDWI decreases. This is because farmers want to stress the grapevines by reducing water amount in the canopy. NDVI in vineyards is expected to have a higher NDVI throughout the year to reflect grapevine growth. Improving our understanding of vineyard monitoring can lead to better understanding of vineyard conditions. With our understanding of the field we can help vineyard managers to improve their decision making abilities when it comes to the vineyards, such as precise irrigation of specific areas to maintain grapevine health.

4) Results



Figure 1: Picture of May Growth



Figure 2: Picture of the Vineyards



Figure 3: Picture of early July

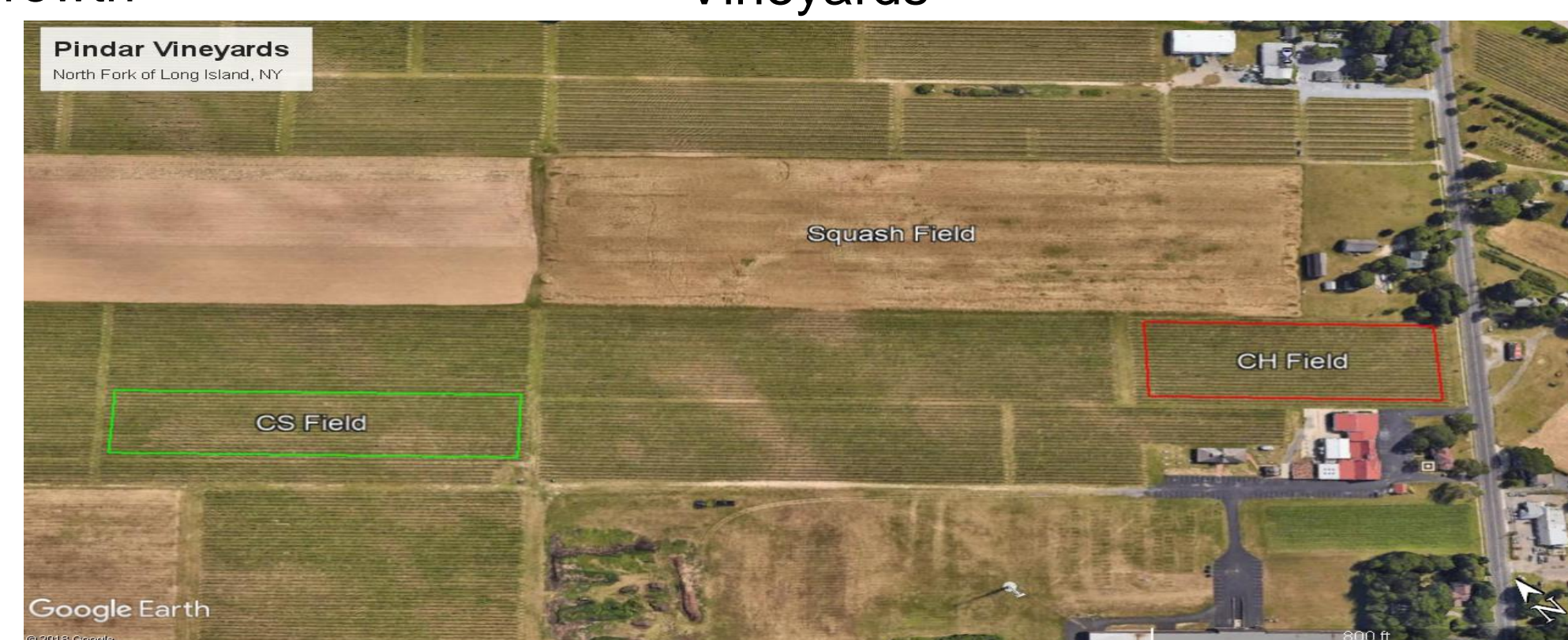


Figure 4: Map of the vineyards. CH = Chardonnay, CS= Cabernet Sauvignon

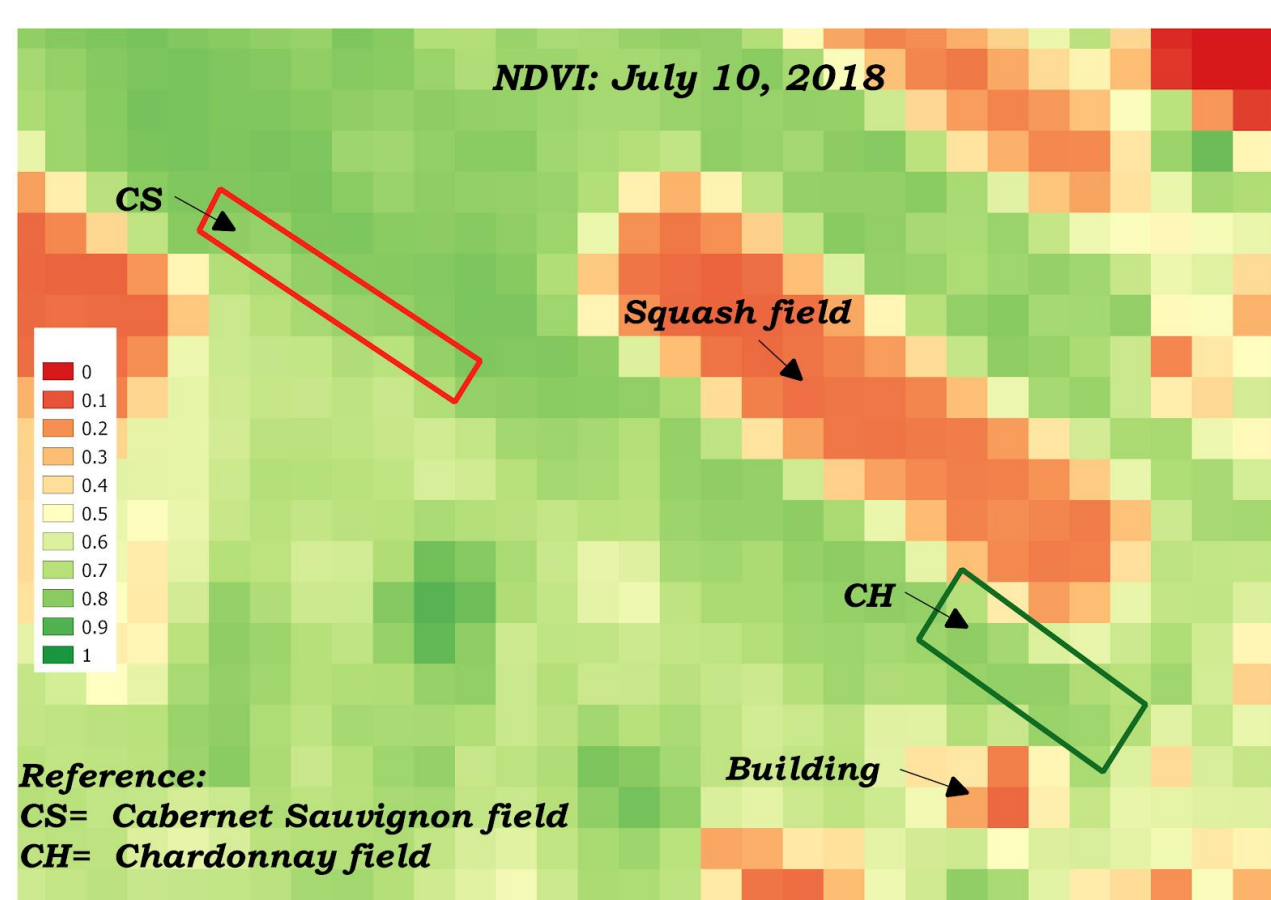


Figure 5: Map of NDVI on July 10, 2018

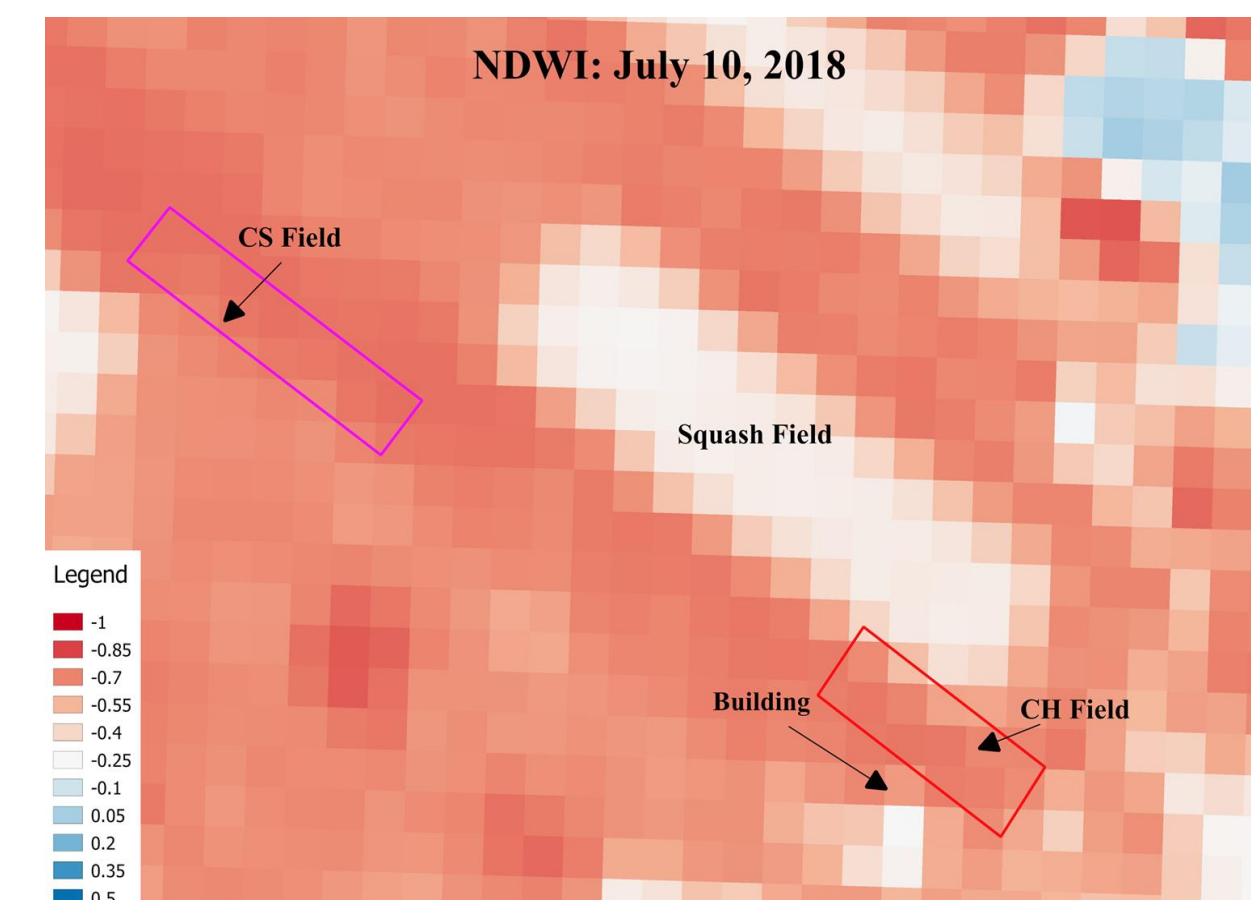


Figure 6: Map of NDWI on July 10, 2018

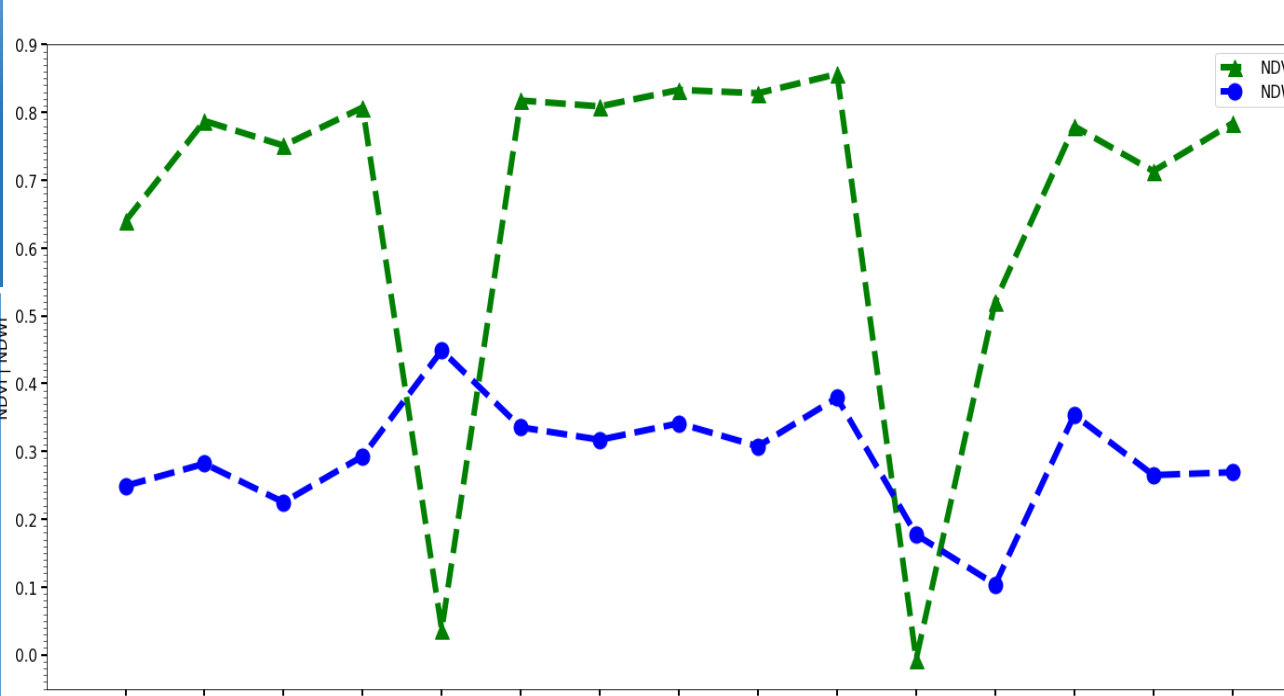


Figure 7: Graph of NDVI (green) and NDWI (blue) for cabernet field

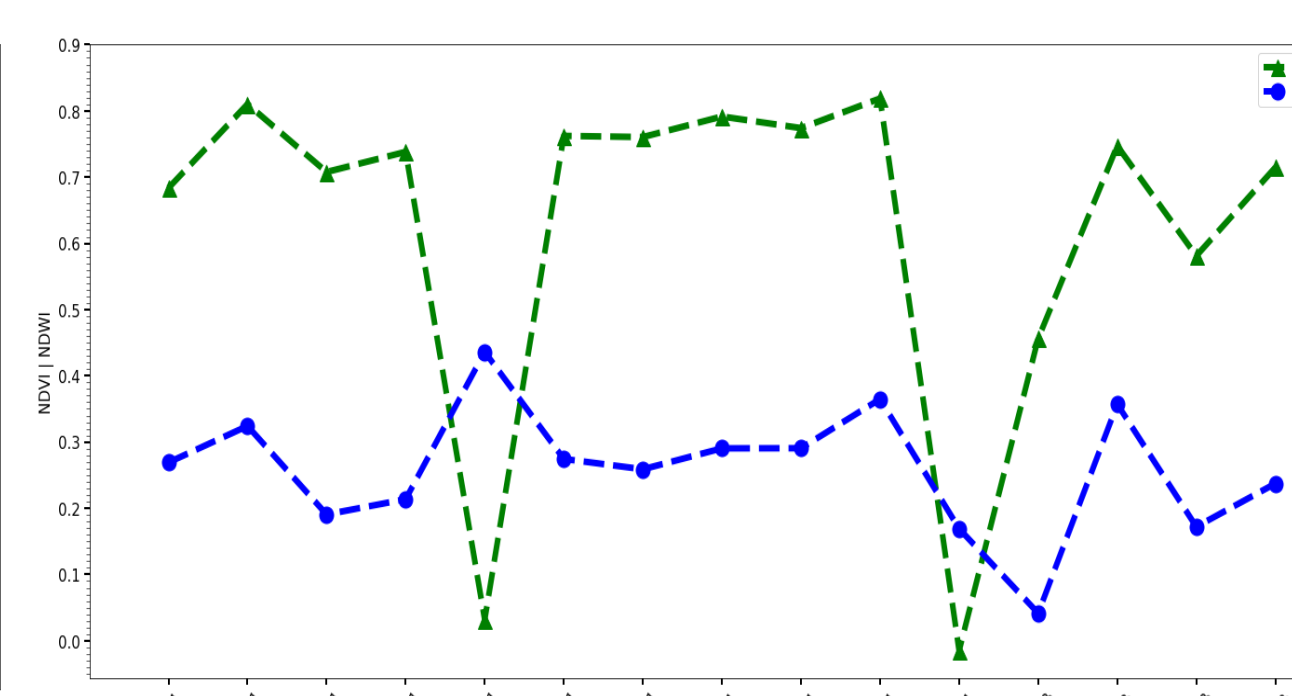


Figure 8: Graph of NDVI (green) and NDWI (blue) for Chardonnay field

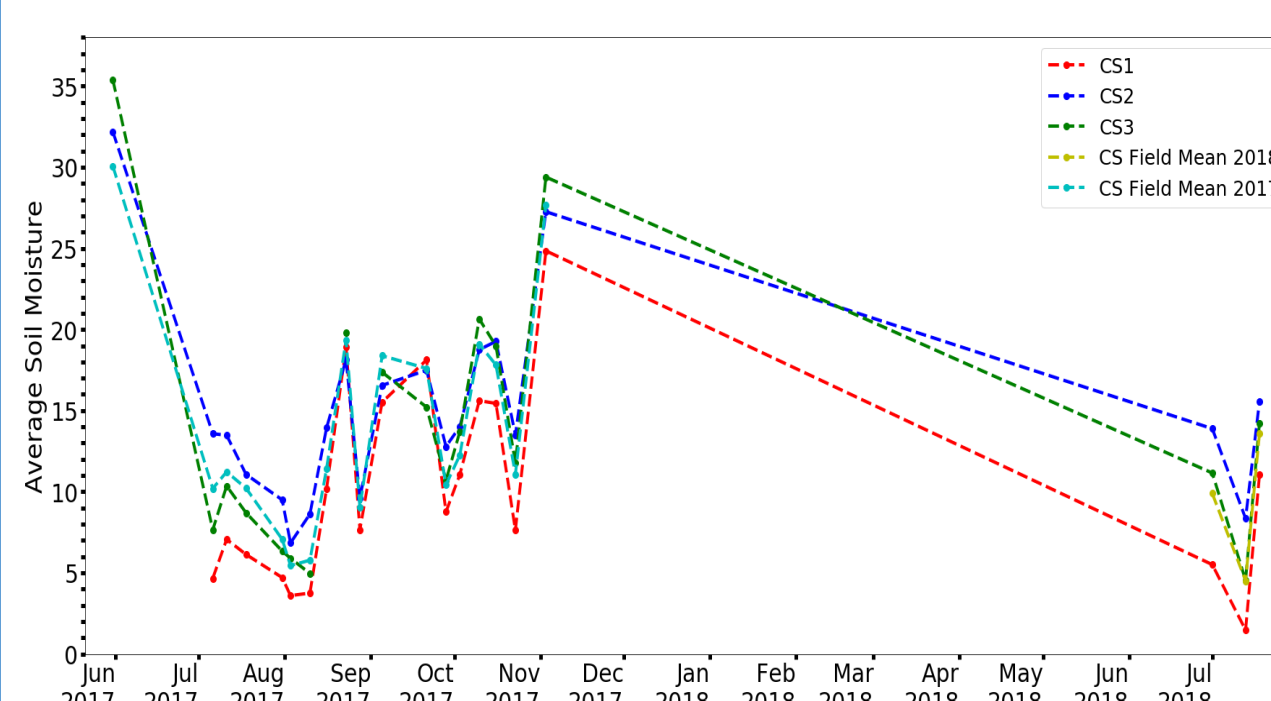


Figure 9: Graph of soil moisture for Cabernet Field, mean value and specific locations shown.

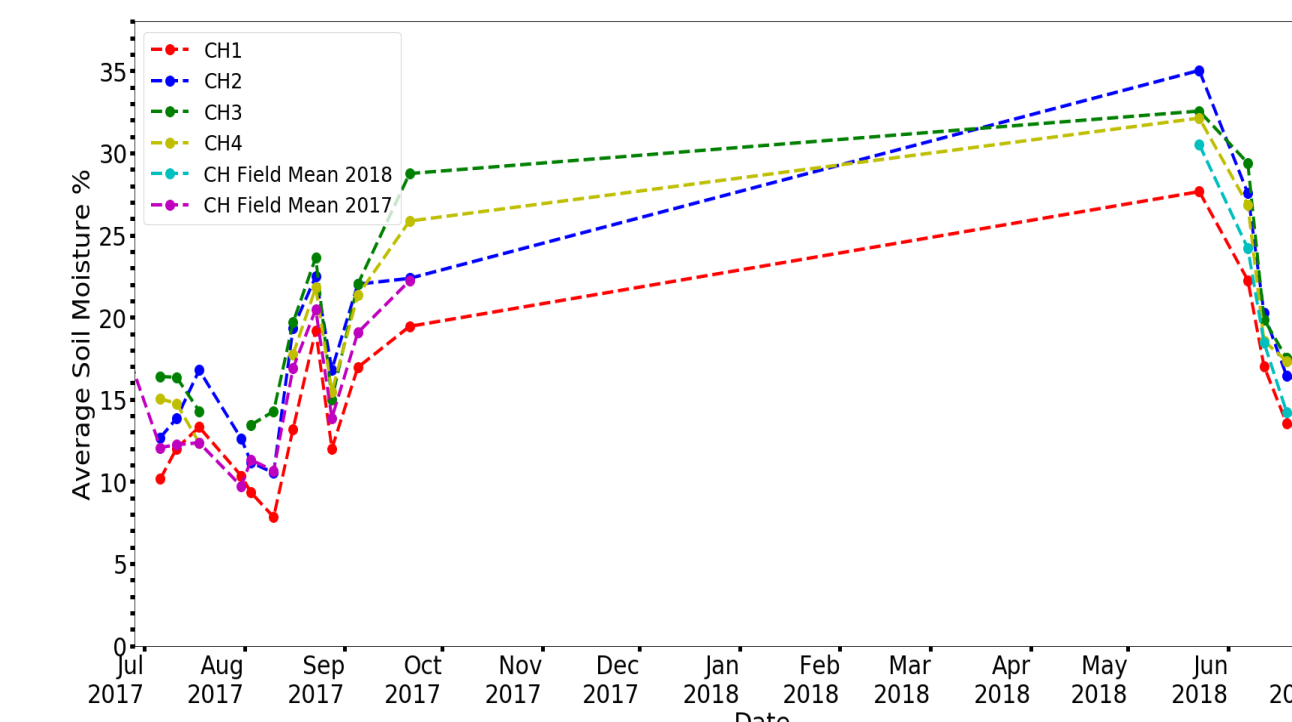


Figure 10: Graph of soil moisture for chardonnay field, mean value and specific locations shown.

5) Methods

- We studied the Pindar vineyards where we looked at two specific fields, Chardonnay and Cabernet Sauvignon located in the North Fork of Long Island, NY.
- We downloaded Landsat 8 data from USGS and extracted and analyzed it in python.
- To measure the vineyards, we used NDVI and NDWI to determine the health of the vineyards.
- We also went out to the vineyard to verify that the vineyard is in fact what we were observing with the satellites. Along with this we collected field data by counting leaves, measuring shoot length and soil moisture using a soil moisture probe.
- Soil moisture, NDVI, and NDWI are expected to be relatively related to one another. NDVI measures the conditions of the vineyard, and grapes require precise amounts of water and canopy trimming in order to make quality wine. Ideally, this is observed in the vegetation indices.

6) Results

- Figures 5 & 6 are images from the Landsat-8 satellite showing NDVI and NDWI variability in the vineyard. The NDVI is the same in both the CH and CS fields, however the NDWI for CS has more water than the CH field does,
- Figure 7 (Cabernet) and 8 (Chardonnay) data shows that the NDVI from the year 2017 to 2018 had only two dips but the NDVI was relatively high overall.
- The parts of the graph that have a dip indicate that clouds were blocking the satellite view of the fields on September 2, 2017 and November 5, 2017 so the satellite could not detect measure the NDVI nor NDWI.
- In 2017 the soil moisture seems to be cyclical all throughout until 2018 in figures 9 and 10.
- When comparing figure 8 and 10 the NDVI and NDWI its at its highest so is the soil moisture.
- NDVI and soil moisture don't seem to be relatively related seasonally because the graphs for soil moisture vary throughout while
- However, NDWI seems to have more variability than the NDVI, this may be a sign that the plants are responding to soil moisture- the grapevines are absorbing water as they grow.
- Since vineyards are maintained constantly we noticed that the NDVI could be responding to the trimming of the grapevines rather than to the soil moisture itself.

7) Conclusions

- Our field work allowed us to verify the satellite images are relatively accurate with identifying field variability and grapevine growth.
- Although the research is not finalized, it is safe to assume that Landsat-8 is tracking the growth of the grapevines using NDVI.
- More analysis is needed to determine if soil moisture is related to the NDWI to determine if the grapevine moisture content is responding to the changing soil moisture throughout the season.
- NDVI is relatively high however this doesn't prove that the grapevines are responding to the soil moisture.
- Establishing relationships can better guide management practices in vineyards with the use of satellite remote sensing.

References

- <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2008GL035772>
- <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/soil-water-deficit>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5394115/>