Spectral index analysis Report

Introduction

The selected study area is Fresno, California, USA at latitude 36.6438° N and longitude 119.9840° W. This area is within a unique region in California called Central Valley where there is a diversity in crop and irrigation patterns. In Fresno, specifically, there are numerous orchards that undergo distinct growing seasons, making the location ideal for NDVI, EVI, and NDMI index analyses during these periods. Additionally, the semi-arid areas of the region often contain exposed soil, making the SAVI index useful for comparison with the other vegetation indices. The objective of this research is to visualize and interpret the various spectral indices in order to better understand the distribution of vegetation and moisture across the landcover of Fresno, California.

Methods

Sentinel-2 SR Harmonized satellite images have a spatial resolution of 10 m for blue, green, red, and near-infrared spectral bands with a revisit time of 5 or less days. Landsat 8/9 Collection 2 satellite images have a 30 m resolution for blue, green, red, and near-infrared bands with a combined temporal resolution of 8 days. The temporal and spatial resolutions in both datasets make them ideal for calculating most vegetation indices. The chosen temporal window is April to October which aligns with the growing season, a period with the densest vegetation. The cloud masking approach excludes cloud shadow, snow, ice, cirrus, medium and high clouds.

Normalized Difference Vegetation Index (NDVI) is most widely used for visualizing general vegetation health. It's formula is:

$$NDVI = \frac{NIR-RED}{NIR+RED}$$

Enhanced Vegetation Index (EVI) is modified from NDVI to correct for atmospheric distortion and soil. It's good for analysing dense canopies where NDVI will max out.

$$EVI = G * \frac{NIR-RED}{NIR+C_1*RED-C_2*Blue+canopyBackgroundAdjustment}$$

$$where\ G = gain\ factor,\ C_1\ and\ C_2\ for\ atmospheric\ correction.$$

Soil Adjusted Vegetation Index (SAVI) is modified from NDVI to minimize soil brightness. It can better visualize regions of early growth stages where the bare ground is visible.

$$SAVI = \frac{NIR-RED}{NIR+RED+soilBrightneess} * (1 + soilBrightness)$$

Normalized Difference Moisture Index (NDMI) is similar to NDVI but uses the short-wave infrared band (SWIR) instead of the red band.

$$NDMI = \frac{NIR-SWIR}{NIR+SWIR}$$

Results

Surprisingly, the EVI index in Fig.3. showed less variance than the NDVI index in Fig. 2. This may suggest that the default atmospheric corrections and canopy background adjustment values need to be altered to better fit the sparse vegetation landcover in Fresno, California.

Water bodies are likely located near the center of the area of interested as indicated by having the highest value in NDMI index in Fig. 5. where the sub-area is colored in a deep blue to correspond to the 0.3 value, the highest value in the determined moisture range from -0.3 to 0.3. The NDVI, EVI, and SAVI indices from Fig 2., Fig 3., and Fig. 4 are used for vegetation so water bodies are indicated by the lowest values which the center sub-area aligns with. All the indices indicate that the region with dense vegetation is at the southwest sub-area and that the northeast sub-area has less vegetation.

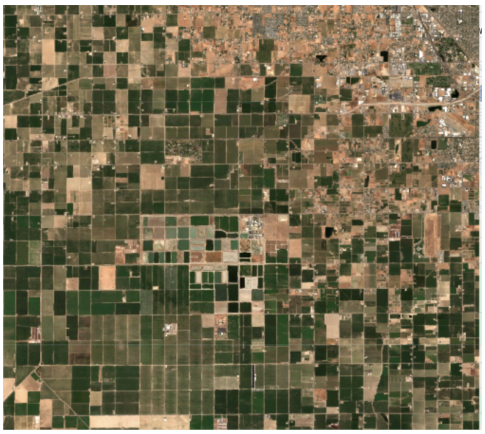

Fig. 1.1. True color index using Sentinel 2 satellite image

Fig. 1.2. True color index using Landsat 8 and 9 satellite image

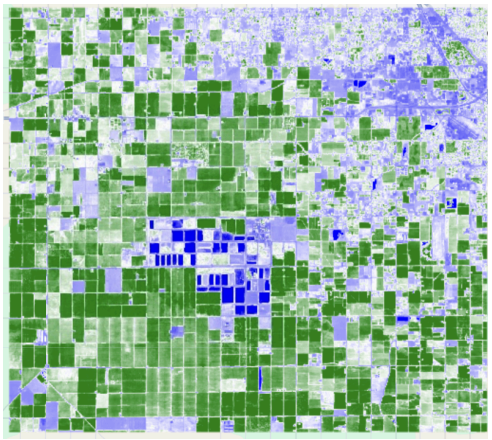

Fig. 2. NDVI index using Sentinel 2 satellite image

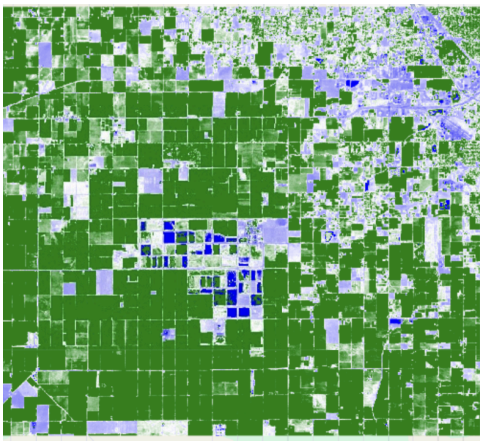

Fig. 3. EVI index using Sentinel 2 satellite image

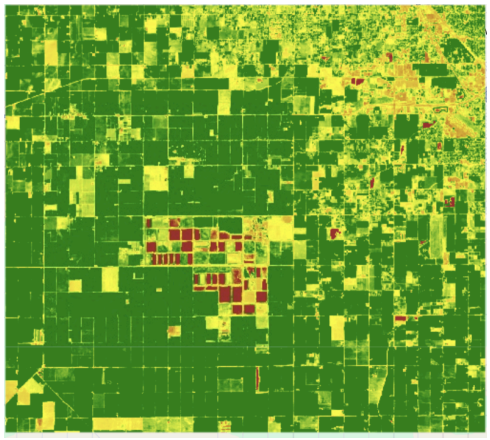

Fig. 4. SAVI index using Sentinel 2 satellite image

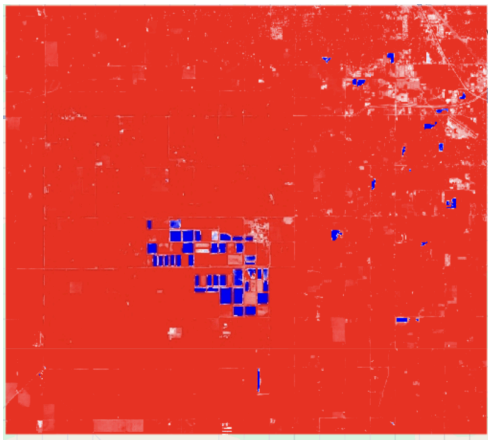

Fig. 5. NDMI index using Sentinel 2 satellite image

Discussion and Conclusion

Fresno, California is a drier region with more sparse vegetation, therefore it can be concluded that NDVI performed well because the values were able to encompass the regions that had less vegetation. NDVI is the optimal index for the region as it surpassed even SAVI in showing variation between different vegetation densities. Sentinel-2 is able to capture more detail than Landsat so its satellite images provide a higher-resolution dataset for fine analysis. Google Earth Engine is simple to use and makes import of data from various satellites efficient and calculations of different indices simple. In Assignment 3.02, the exported datasets will be used to calculate four new and different indices: GNDVI, MNDWI, NDBI, and NDMI.