VEGETATION INDICES

Vegetation Indices (VIs) are multi-wavelength combinations of surface reflectance that highlight a specific feature of vegetation. They're calculated using vegetation's reflectance qualities and each vegetation index is intended to highlight a different aspect of the vegetation. Solar radiation reflected from ground targets is measured using optical satellite sensors. Each channel is sensitive to light in a specific wavelength range, such as blue, green, red, near infrared, or short wave infrared. Low values in the blue and red bands, slightly higher values in the green band, extremely high values in the near infrared band, and low to high values in the shortwave infrared bands are seen in the reflection of radiation by plants (depending on the wavelength).

Three vegetation indices have been chosen to determine the health status of crops at different development of the crop up to maturity or ripening. This was determined based on the fact each index is effective at different stage of crop growth and ineffective at another because of various factors. These factors include saturation levels, effects of soil (brightness, color, moisture content, presence of iron oxide and salinity), atmosphere (cloud cover and shadow) and leaf canopy shadow (ESRI, 2018)

During the planting/ germination stage, modified soil adjusted vegetation index (MSAVI) which utilizes the Near-infrared band and red band will be used because it minimizes the soil brightness influence using a soil brightness correction factor. With a factor less than 0.2 it indicates bare soil and when compared to Normalized difference vegetation index (NDVI) it will also be below factor 0.2. Moreover, Normalized Difference Red Edge Index (NDRE) will be below 0.1 indicating bare soil or rock or snow.

As the MSAVI value ranges between 0.2 and 0.4 it indicates the crop has started germinating and as it is compared to NDVI the value has also started increasing from 0.2 while NDRE is showing a factor slightly above 0.1. From 0.4 to 0.6 it indicates the leaf development stage and that’s when the NDVI becomes effective in monitoring crop health because it saturates at a high biomass of 0.7.

NDVI utilizes the Near infrared and the red bands. As earlier indicated, having a factor less than 0.2, it indicates bare soil, rock or snow. When values range between 0.2 and 0.5 it indicates sparse vegetation with developed leaves. However, low values indicate moisture stressed vegetation, nutrient deficient vegetation or bacterial/parasitic attacks. Since NDVI saturates in dense vegetation, a factor above 0.5 will always indicate dense vegetation.

To effectively monitor crop health in dense vegetation, we will use NDRE (Normalized Difference Red Edge index) because it concentrates on plant’s canopy density and greenness in the lower layers of the crops. It utilizes the Near infrared and the red bands. Factor range between 0.2 and 0.6 indicates a not mature crop or sickly crop due to water stress or fertilizer stress. As the values goes above 0.6 it indicates a healthy, mature, ripening crop (Ceccato et al. 2001).

Since all these indices may not quickly detect any stress in the crop, Normalized Difference Moisture index (NDMI) will be used as it quickly detects changes in the moisture content in the internal structure of the leaves which correlates to water stress in crops. It utilizes Near-infrared and Short Wavelength Infrared bands. A factor less than -0.6 indicates bare rock while a range between -0.4 to 0 indicates high water stress (sparse vegetation). As the factor increases to 0.4 it indicates low water stress (mid dense vegetation) and factor above 0.4 will indicate no water stress (dense vegetation) (Jensen 2004)

Modified Normalized Difference Water Index (MNDWI) which utilizes green and Short Wavelength Infrared bands is used to distinguish open water sources such as reservoirs from dry land as water bodies have minimal radiation and high absorbability therefore effectively suppress built up land noise. If the factor value is greater than 0.5 it indicates presence of a water body and values between 0 to 0.2 indicates the presence of built up features and vegetation.

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