

Drones Light and Energy: Data and Mapping



There are a range of drones available which can perform different duties based on the camera type used, which can be swapped out if the drone type allows. The data sets obtained from a flight can be quite large and processing complex. Although, help is available through the use of software and consultants to provide deep insights to guide management actions and improve practices.

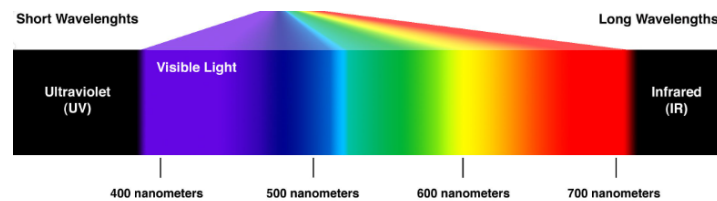


Most drones will capture imagery from a high resolution camera during a usefull for plant health and general monitoring. When fitted with a Light Detection and Ranging (LiDAR) camera, it becomes a powerful tool by sending rapid light pulses to capture point cloud data (Just that: gps X/Y and height Z points!) of the surface. By referring back to an RTK base station it provides cm level accuracy. The points can then be processed to build raster data sets (pixelated imagery), some examples of these are these are;

- **Digital Elevation Models (DEM):** 3D representation of the bare earth surface.
- **Digital Terrain Models (DTM):** 3D representation of a terrain surface, including contours, rivers, and ridge lines.
- **Digital Surface Models (DSM):** 3D representation of elevation, natural and built surfaces.

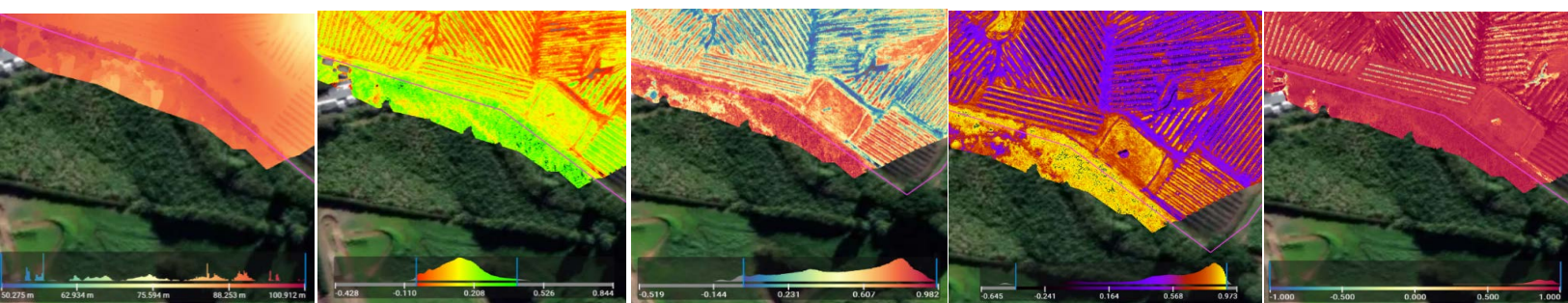
Processing of these models is usefull to view slope (rise and fall in degrees or percent), aspect (slope direction), and hillshade. They can identify surface properties, allow modeling of water flow, accumulation, run off and soil loss. Further it can pinpoint location of each tree, measure canopy heights, and density, all valuable insights to estimate crop volumes.

Plant Health Visible light is a form of energy travelling in wavelengths. Measured in Nanometers (NM), below 380nm is Short wave Ultraviolet (UV), and above 750nm is Long wave Infra Red (IR). Humans see 380-750nm, while plants use the bands known as Photosynthetic Active Radiation (PAR).



The total PAR received by the plant is measured in Umol, some is absorbed and forms the total dry matter (yield), while additional light is reflected. Using multispectral imaging from drone flights we can tap into these plant signatures to provide spatial insights through various vegetative indices, some of these are:

- **Normalised Differential Vegetative Index (NDVI)**- Green vegetation absorbs light during photosynthesis and reflects energy in the Near Infrared (NIR). NDVI decreases as leaves come under water stress, become diseased or die.
- **Red Edge NDVI (NDRE)**- Measures the amount of chlorophyll in the plants and guides plant vigour stress, Nitrogen uptake and fertiliser demand for foliar applications not soil.
- **Blue NDVI (BNDVI)**- Uses the visible blue and is without the red.
- **Structure Intensive Pigment Index (SIPI)**- Used in areas with high variability in canopy structure (e.g. forestry).
- **Green NDVI (GNDV)**- Uses NIR and the green spectrum band.
- **Leaf Chlorophyll Index (LCI)**- Assesses chlorophyll content in areas of complete leaf coverage.
- **Optimised Soil Adjusted Vegetation Index (OSAVI)**- Minimises the effect soil brightness can have on the result, generally used in arid areas.



DSM Shaded Relief

NDVI

NDRE

BNDVI

SIPI



Why-Values-Calculate



NDVI Red (rRed) and Near-Infrared= Quantifies forest supply and Leaf Area Index ($LAI = \text{leaf area (m}^2\text{)} / \text{ground area (m}^2\text{)}$). Usefull during early and mid development. Can lose sensitivity at high levels of canopy density. Higher values means higher Chlorophyll content, greater density and greenness of the canopy, typically .3 is diseased, 0.5 indicates low vigor.

Values -1 and +1, bare soil close to zero, water bodies negative values. $(rNIR) + (rNIR - rRed) / (rNIR + rRed)$.

NDRE= Better indicator of vegetation health/vigor than NDVI for mid to late season crops that have accumulated high levels of chlorophyll in their leaves. This is because red-edge light is more translucent to leaves than red light therefore less likely to be completely absorbed by a canopy.

Values -1 and +1, bare soil close to zero $(NIR - RED\ EDGE) / (NIR + RED\ EDGE)$

BNDVI= Used in areas sensitive to chlorophyll content.

Values -1 + 1 bare soil close to zero, water bodies negative values $(NIR - Blue) / (NIR + Blue)$

GNDVI= Measures rates of photosynthesis, water and nutrient uptake therefore plant stress. Usefull for the later stages of development.

Values -1 + 1 bare soil close to zero, water bodies negative values $(NIR - Green) / (NIR + Green)$

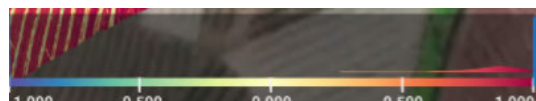
SIPI= Measures Light Use Efficiency (LUE), the efficiency that vegetation can use light for photosynthesis. LUE is related to carbon uptake and vegetative growth. Monitor vegetation health, plant stress, crop production and yield analysis.

Values from 0 to 2., common range for green veg is 0.8 to 1.8. $(NIR - BLUE) / (NIR - RED)$

OSAVI= High values indicate denser, healthier vegetation whereas lower values indicate less vigor.

Values from -1 to 1. $(NIR - RED) / (NIR + RED + 0.16)$

Note: The value ledgends follow the same order as images listed above from top left to bottom right



What to do with all this Data?

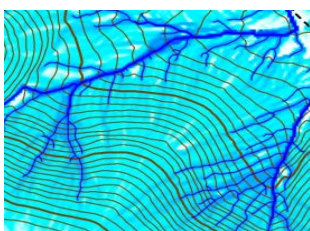
Additional mapping can be done using paid or free mapping services. Keeping in mind the use of some mapping software can be complicated. Specialist drone software can help plan preflight missions and process the LiDAR flight data. Generally a computer with a 4gb graphics card is required. Help is available with the outputsbinvaluable to form deep insights of the farm, create plans and to guide practice change and management actions.

Spraying and Fertilising - There are limitations on using drones for these applications such as tree and orchard size, flying under nets and tunnels. You could spread fertilser and spray over net (depending on height), although you cant fly underneath close net and tunnels. There are various options to choose from which deliver variable spray rates and carry various payloads, for example

- DJI Agras T10 2.4litres per minute, 8kg carrying capacity spreading width 7m 5ha/hr
- DJI Agras T30 40 litre capacity 7m spreading width 1ton/hour 16ha/hr.
- DJI Agras T40 orchard 4/ha/hr 1.5t/hr
- XAG R150kg capacity autonomous/remote control ground vehicle. Travels 1.2m/s spray 5ha/hr to a max width of 12m

Consider your options, you might want to spot spray only, even spread seed or beneficial insects. If using a contractor it is best to contact for pricing and more information relevant to your site to form the business and use case.

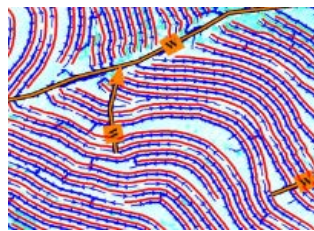
There are restrictions on the use and in most cases drone use requires a licence. Multispectral wont penetrate tunnels, More on Agricultural Indices [HERE](#) and Data processing [HERE](#) Lead into photosynthesis Umol Transpiration ventilation of Tunnels,etc [HERE](#)



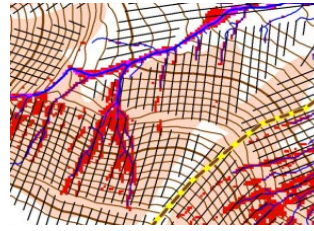
Flow Line



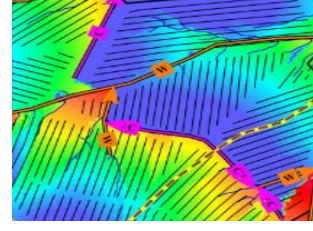
Contour Planning



Soil Loss Equation



Drainage



Slope Length with Drains