UAV/Drone GIS processing

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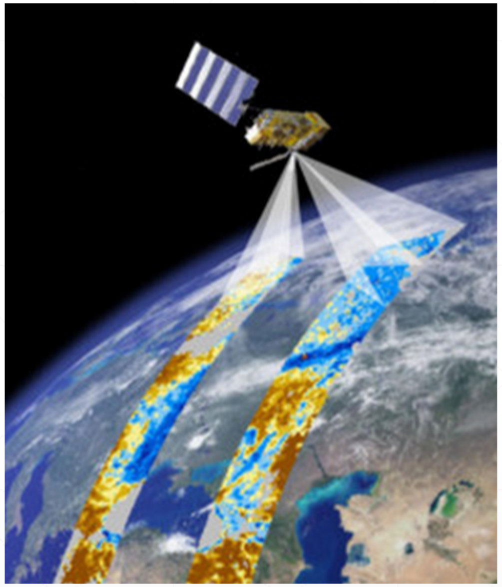
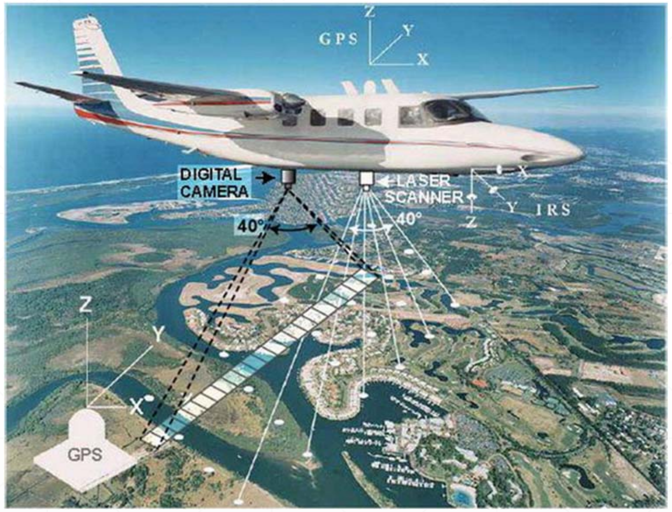
Types of remote sensing data



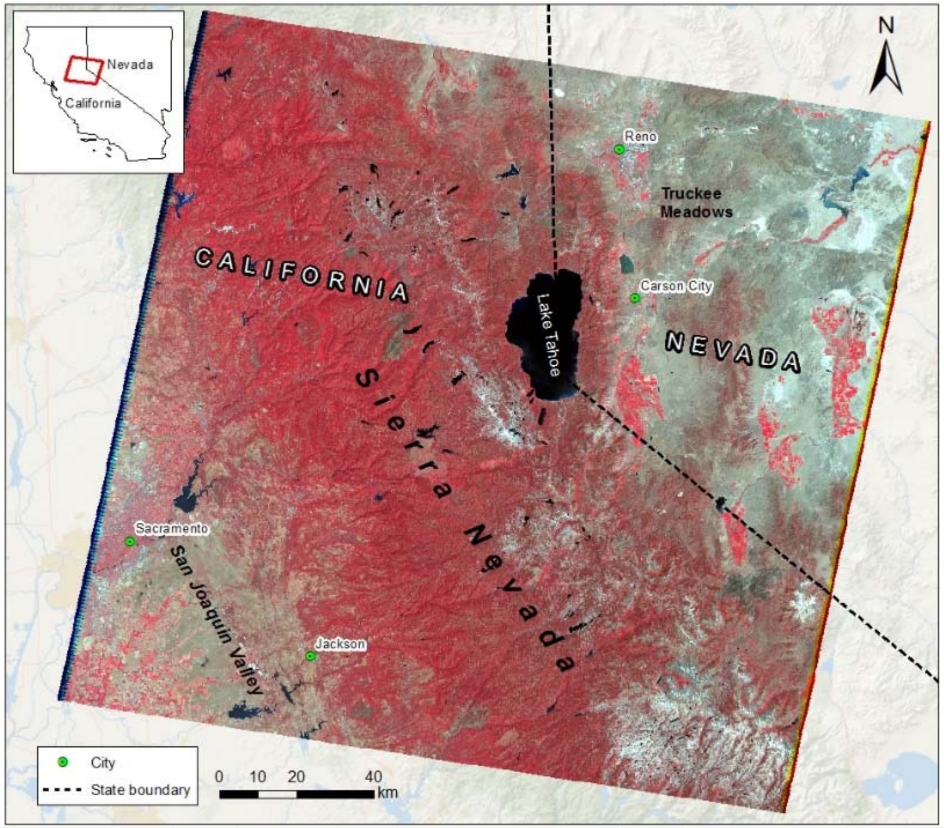
Satellite remote sensing



Aerial remote sensing

UAV remote sensing

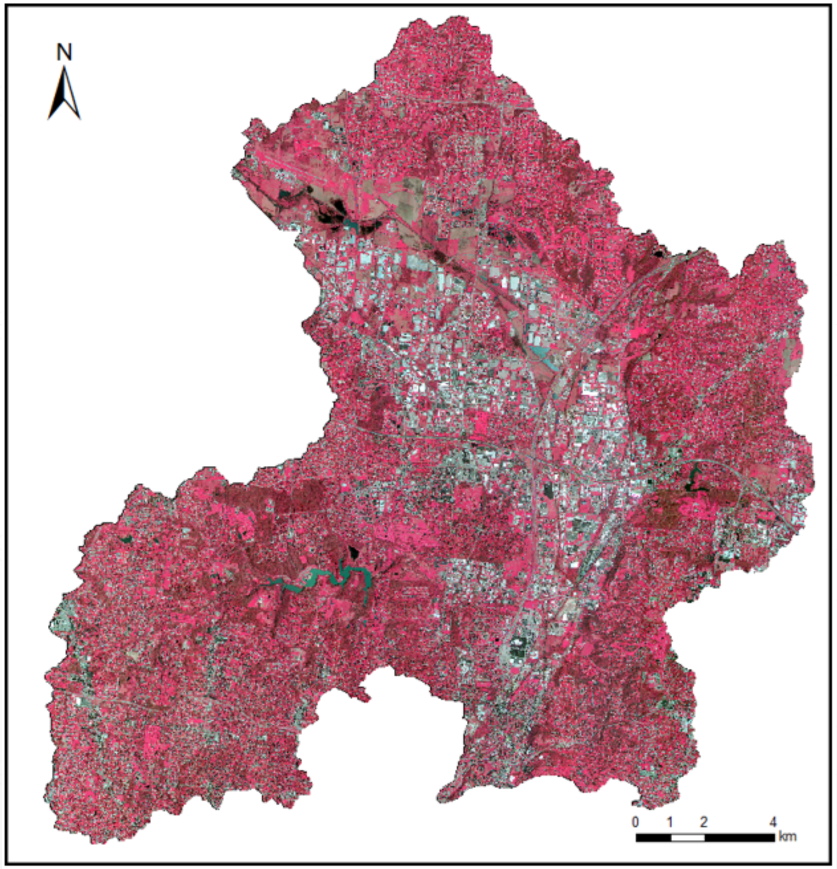
Satellite remote sensing



Landsat NIR false color composition multi-spectral imagery

- Pros
  - Temporal revisiting cycle, historical data
  - Easier to obtain
  - Multi-spectral data
- Cons
  - Moderate spatial resolution
  - Can’t obtain the target day
  - Cloud coverage

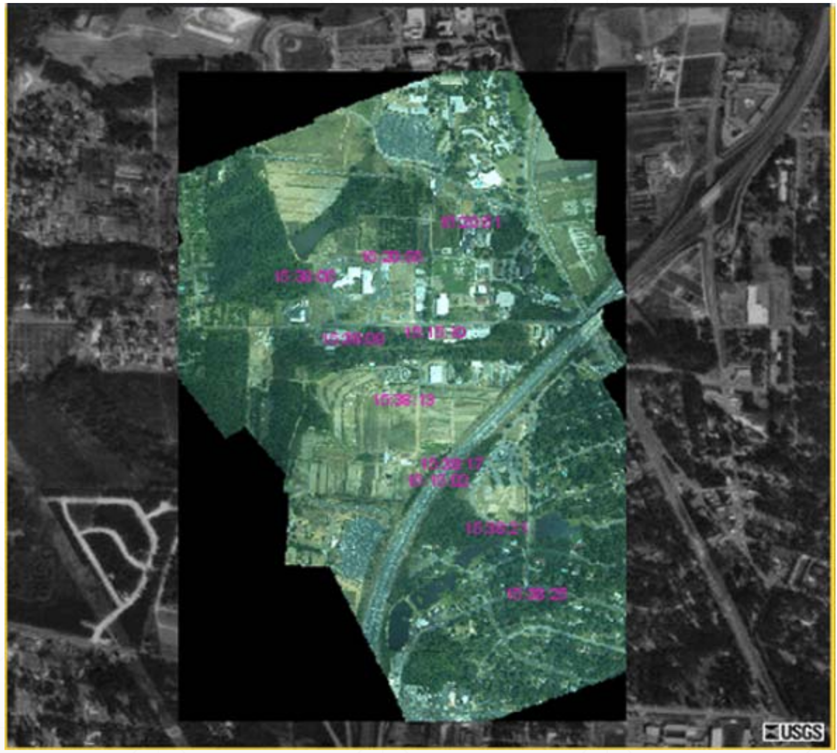
Aerial remote sensing



OSIP aerial imagery NIR false color combination at 1 m resolution

- Pros
  - High spatial resolution
  - Date can be control
  - Multi-spectral, LiDAR, Thermal sensor optional
- Cons
  - Expensive
  - Need pilot and plane
  - Long repeating cycle

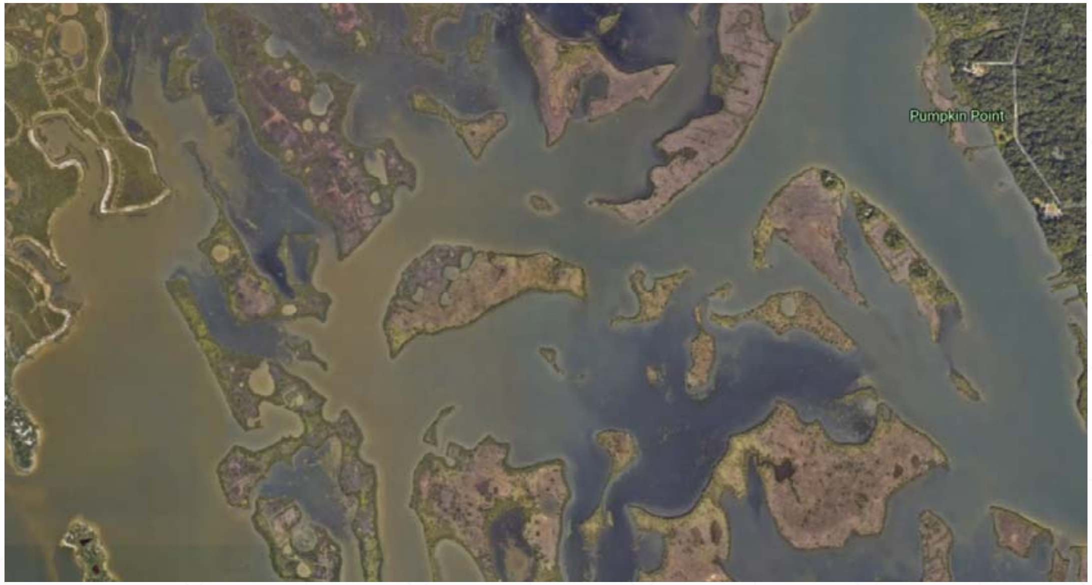
UAV remote sensing



USGS Drone imagery

- Pros
  - High spatial resolution
  - Real-time data acquiring
  - Cheap and convenient
- Cons
  - Accuracy
  - Image stitching and processing
  - Data validation

Drone vs. satellite mapping



- In addition to providing spectacular photos and videos for their aesthetic value, drone imagery can complement satellite imagery to improve scientific analysis and resource management.
- Drones have the power to obtain real-time, high-resolution images, as well as footage features.
- You can see how the drone image (right) is more clear and up-to-date than the satellite imagery (left).

UAVs

DJI phantom 4 Pro

- Budget: $3000
- Fly time: 28 min
- Payload: 600g

Parrot Bluegrass

- Budget: $2000
- Fly time: 26 min
- Payload: 500g

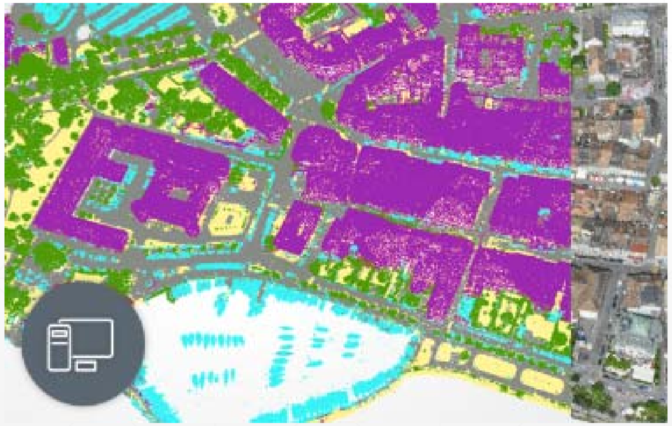
DJI Matrice 600 Pro

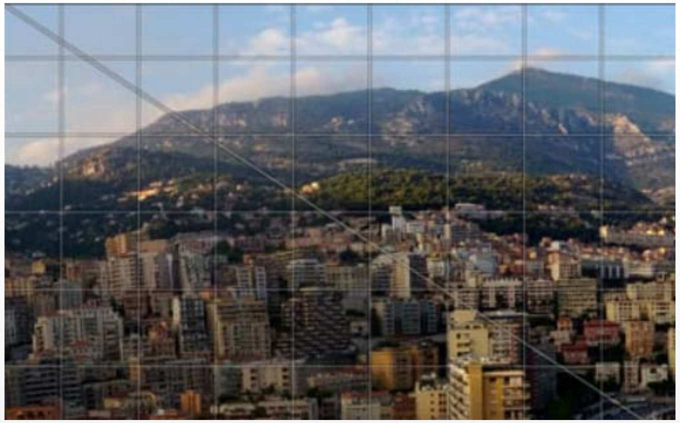
- Budget: $8000
- Fly time: 42 min
- Payload: 1000g

Drone image processing tools

- **Esri Drone2Map**
  - Orthomosaic Imagery
  - Ground Control Points (GCPs)
  - Elevation products
  - 3D Imagery Products
- **Pix4D Mapper**
  - Purely from images
  - Machine-learning algorithm
  - Point cloud classification
  - Camera self-calibration
- **Agisoft PhotoScan**
  - Georeferenced orthomosaic export
  - Photogrammetric triangulation
  - Dense point cloud:

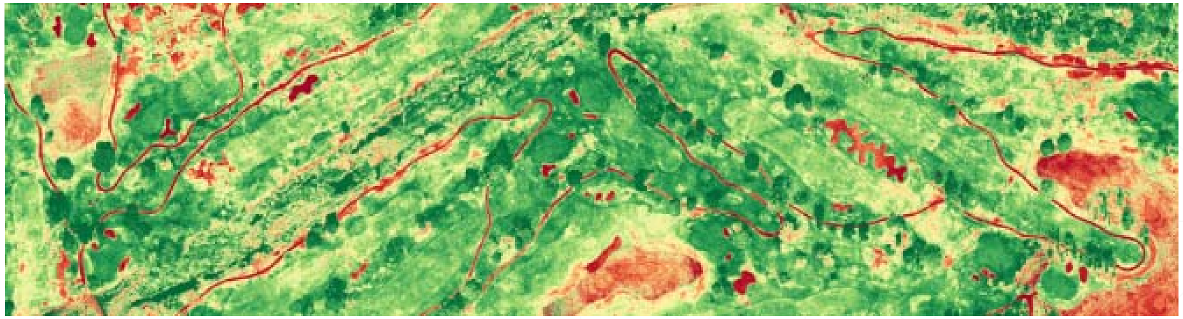
    editing and classification





Sensors

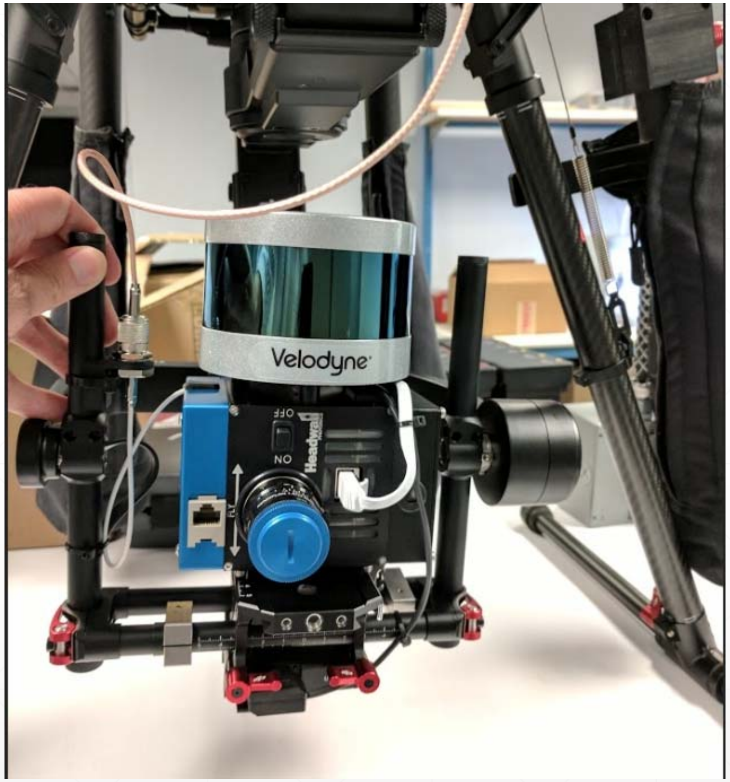
- Bluegrass multi-spectral camera

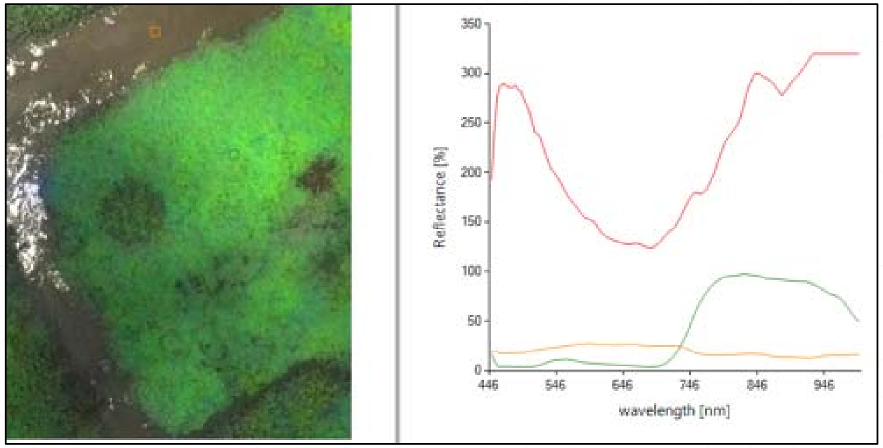


- NIR, Red edge, Red, Green, Blue
- The filters capture 5 channels of light information
- RGN Filter (NIR+ Red+ Green)

Sensors

- ➢ Headwall Hyperspec VNIR Turnkey Package

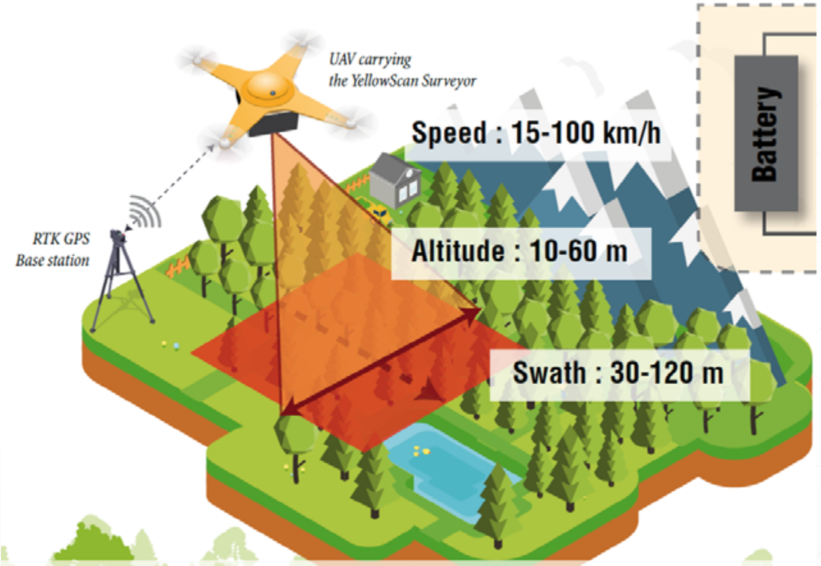




- ➢ **Hyperspectral** - 270 spectral bands
- ➢ Ortho-rectification and RGB mosaic stitching
- ➢ Standard GPS included, SpectralView spectral
- ➢ Classification and data analysis

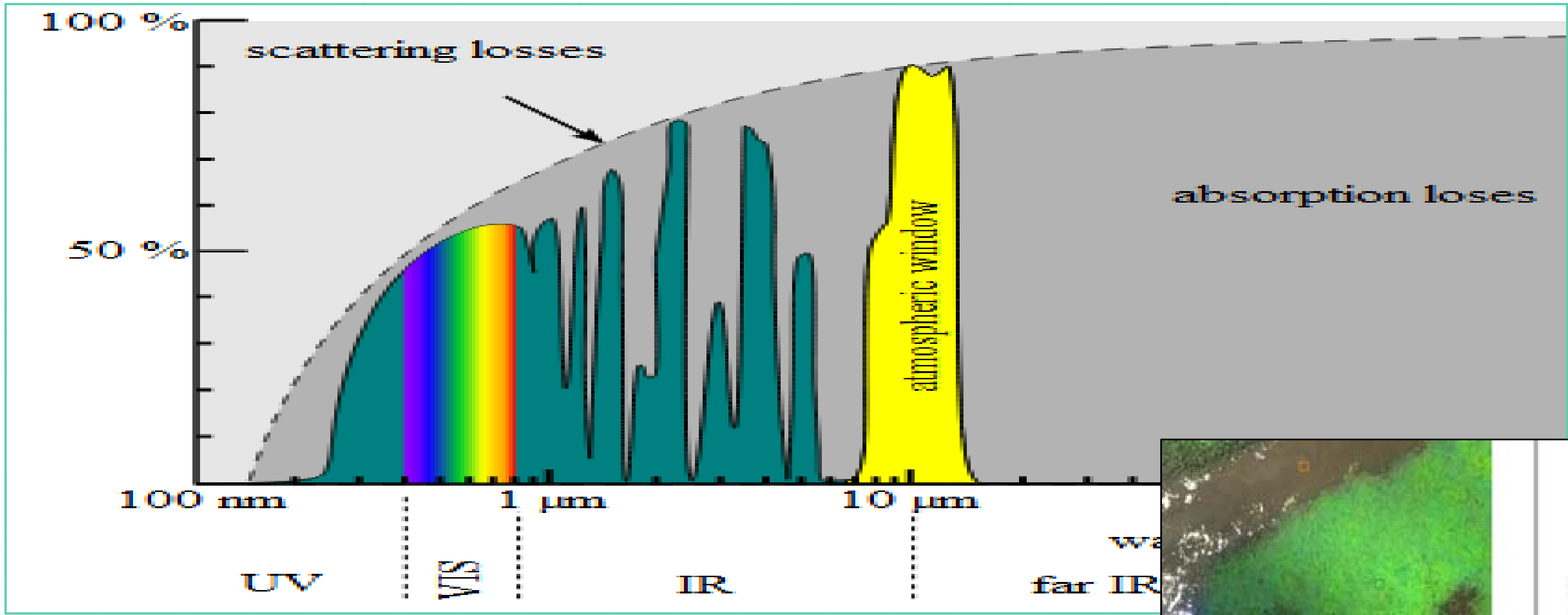
Sensors

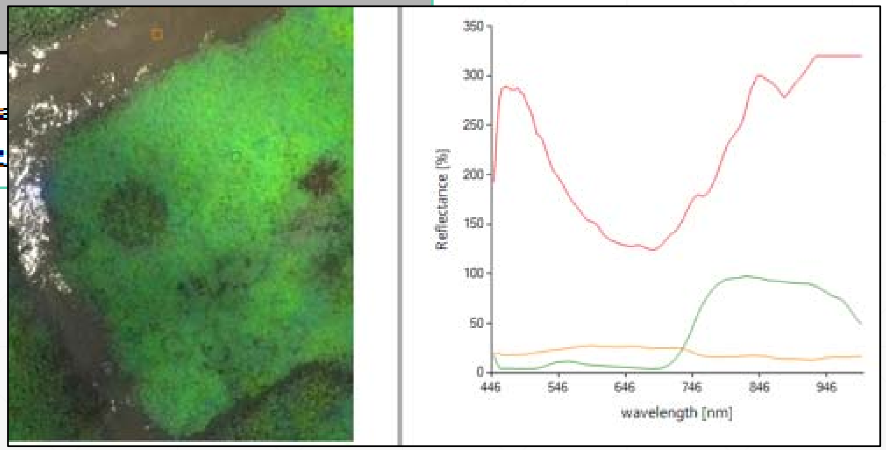
- YellowScan Mapper II UAV LiDAR sensor



- UAV **LiDAR** scanner
- High resolution DEM/DSM
- Precision: 4 cm
- Accuracy: 5 cm

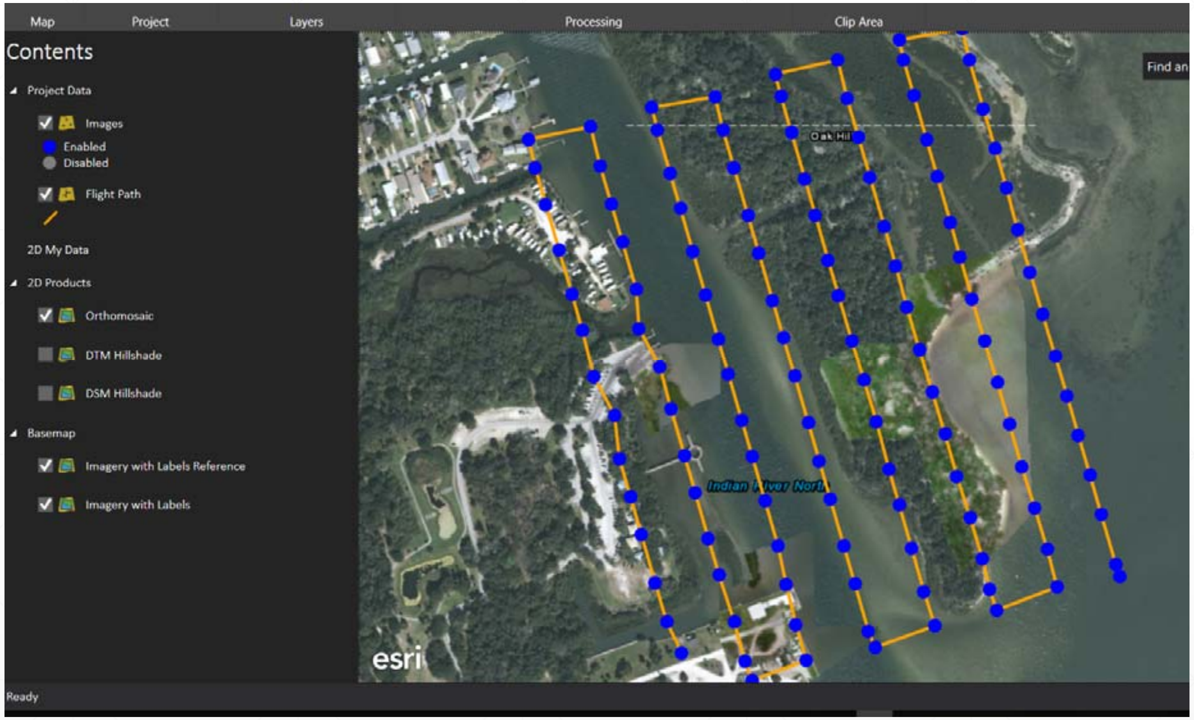
Advance of multi-spectral drone mapping

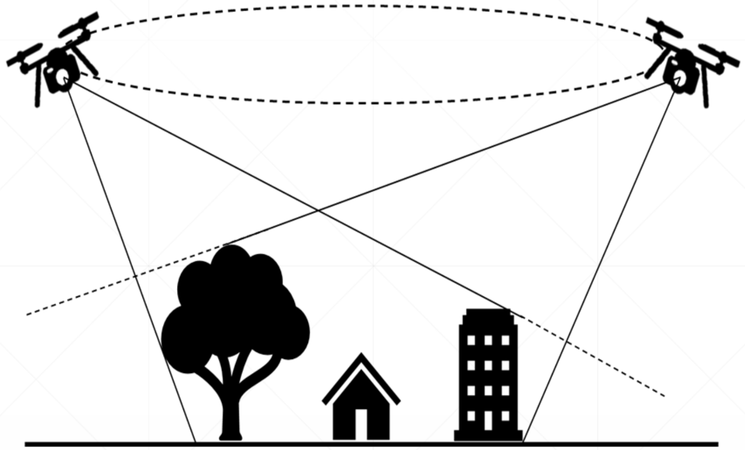




- Vegetations are more responsive to the NIR band
- Obtain a spectral signature from multi-spectral mapping
- Better classification, canopy detection

UAV high resolution data

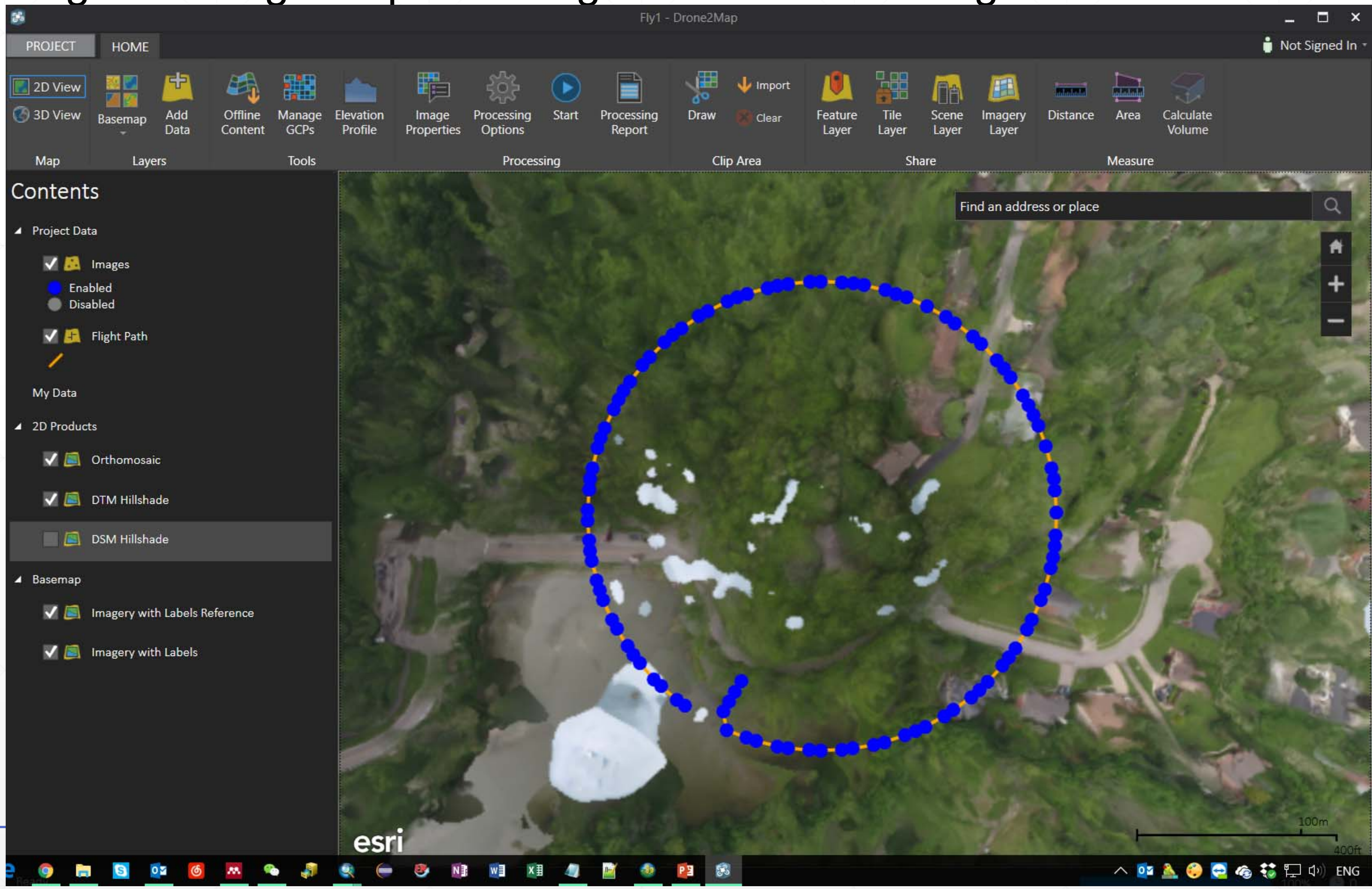




- Flying plan
- GCPs and fly path

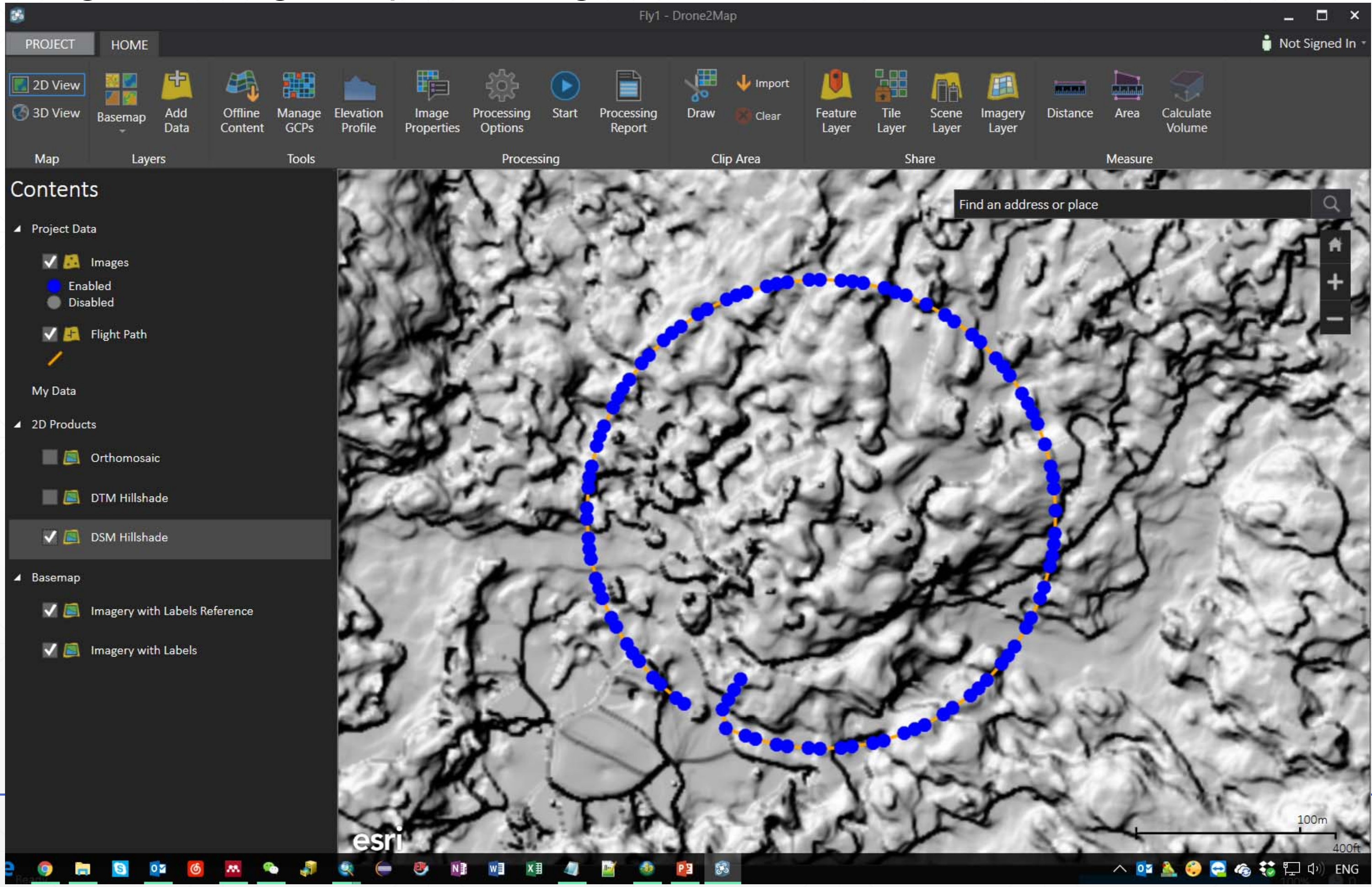
UAV high resolution data

- UAV image stitching and processing - Orthomosaic image

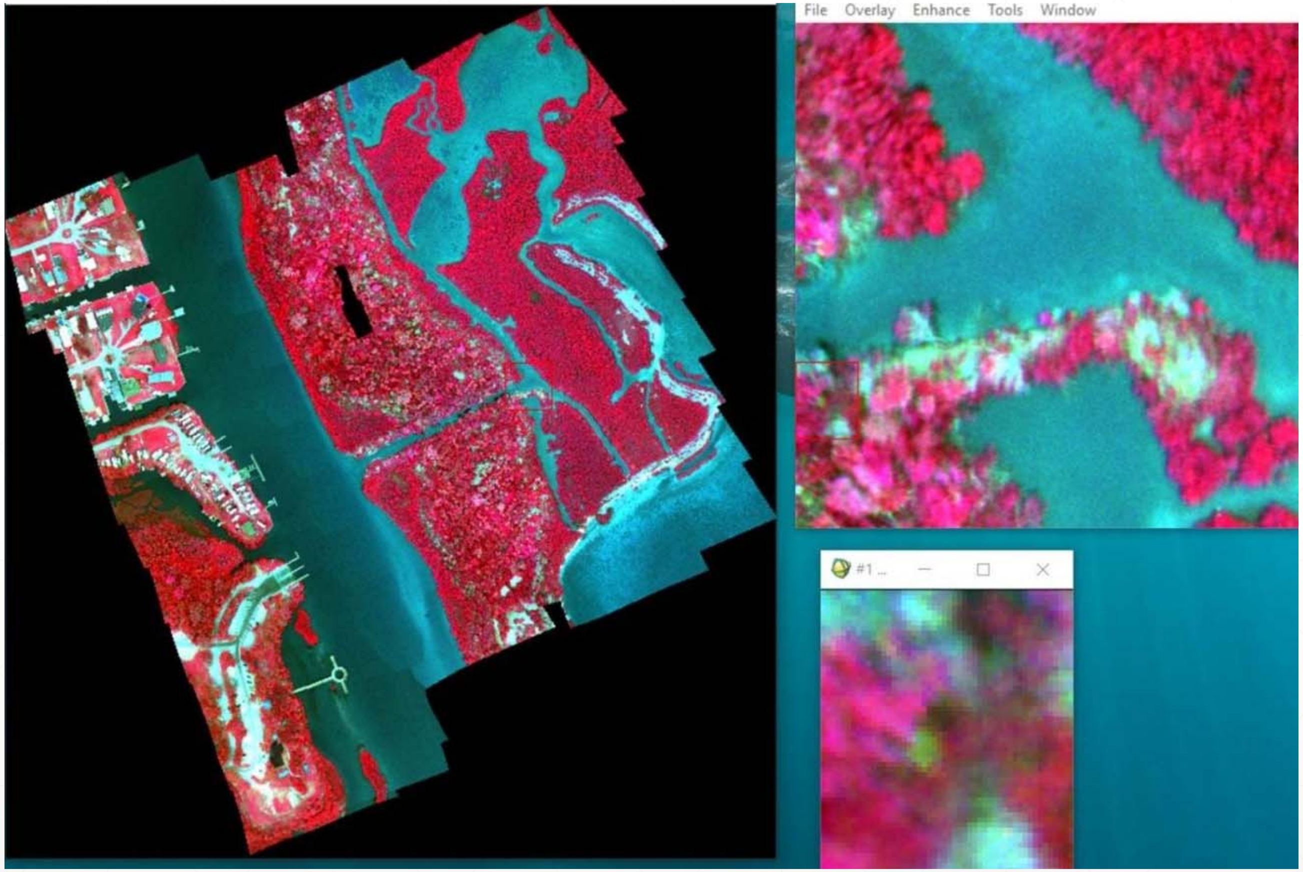


UAV high resolution data

- UAV image stitching and processing - DSM hillshade



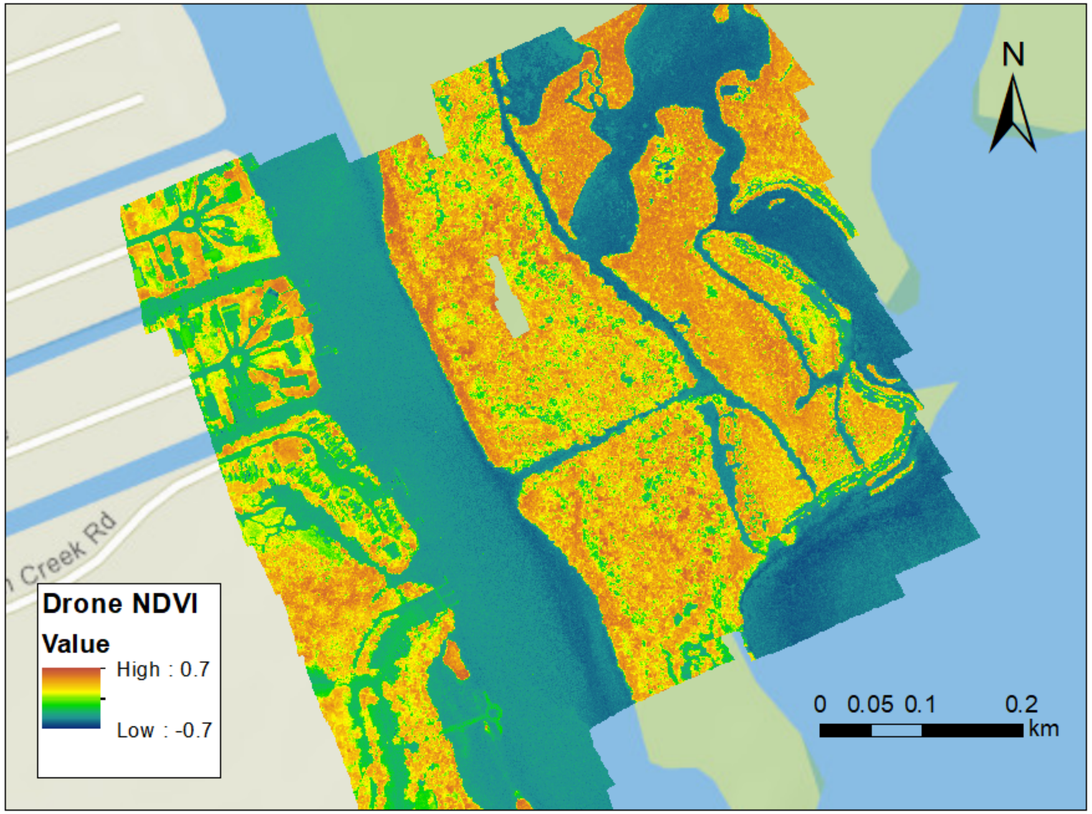
Multi-spectral and RGB data



Parrot multi-spectral

DJI RGB

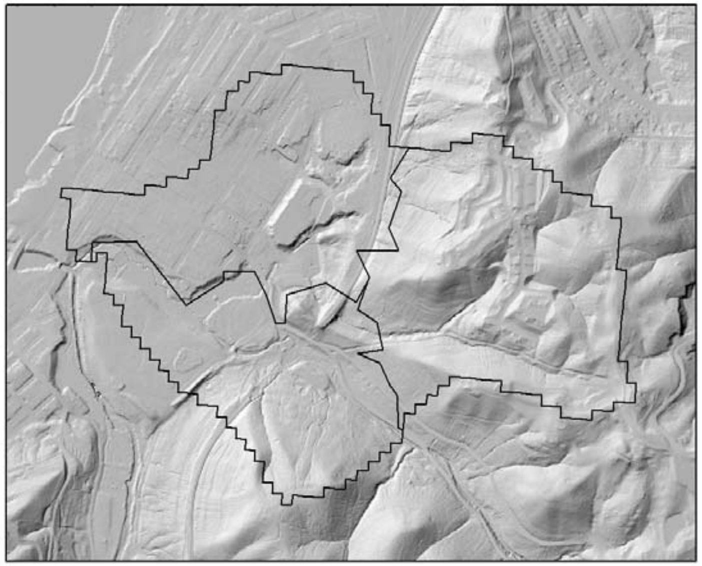
Normalized difference vegetation index (NDVI)



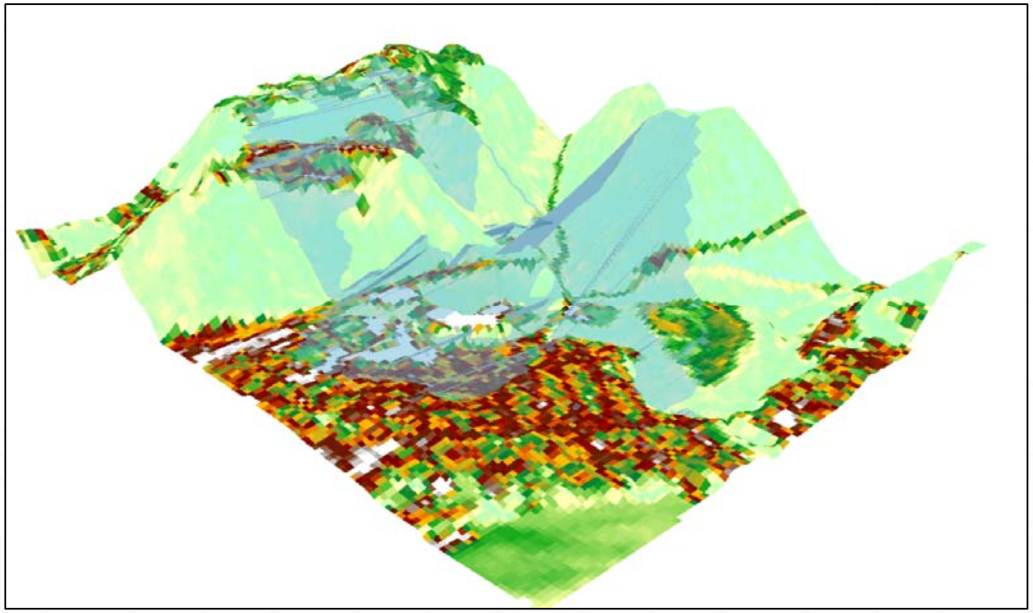
- NDVI could be calculated from the drone mapping imagery.
  - NDVI is utilized to analyze whether the area contains live green vegetation or not.
  - water bodies (from −0.0175 to −0.328)
  - Built environment (−0.019 to 0.060)
  - bare soil (−0.001 to 0.166).
  - dense vegetation (0.500 to 0.575)

UAV high resolution data

- UAV image stitching and processing



DEM hillshade (1 m)



3D View of DEM

The aims of field survey

- 1. To identify each feature of interest (e.g. each habitat type).
- 2. To locate representative areas of each feature in order to generate spectral signatures (spectra) from the imagery.
- 3. To generate adequate additional data to test the quality or accuracy of the image classification (i.e. habitat map).

Global Positioning Systems (GPS)

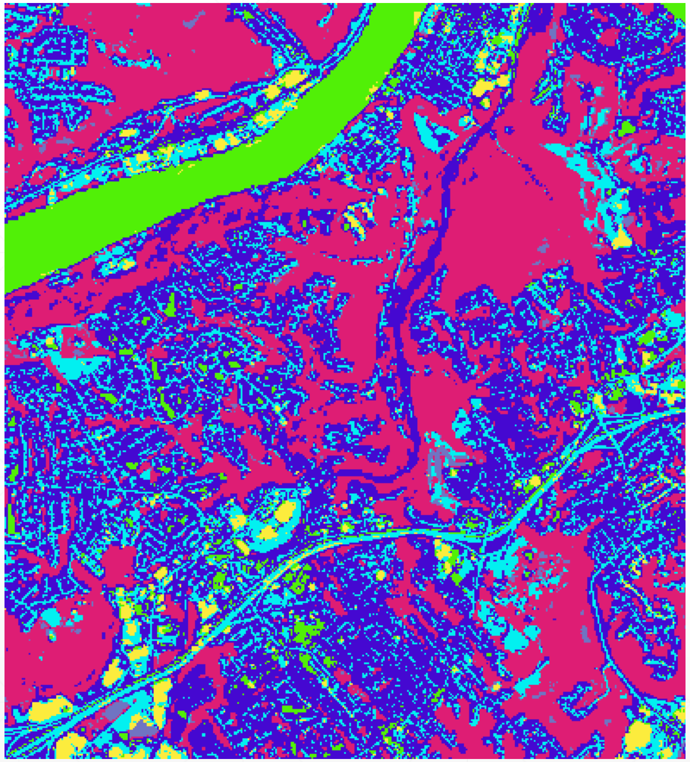
1. to measure the position of prominent features on an image *in situ* which can be used to provide ground control points for geometric correction
2. to assign positions to field data. These field data can then be correlated with spectral information at the same point on a geometrically corrected image.

Ground Control Points (GCPs)

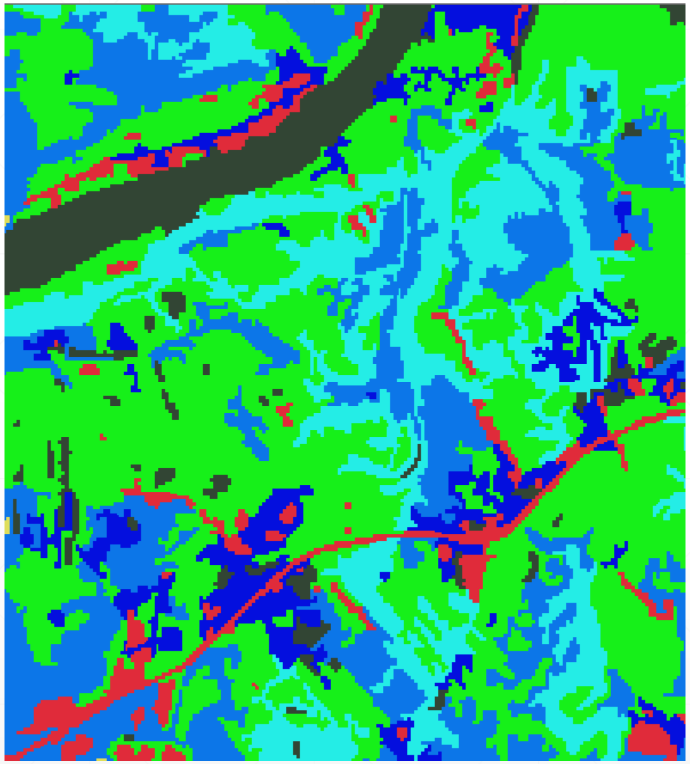
- Use GCPs to calibrate the Drone imagery
- Collected by Garmin R1 GNSS system
- GPSs located in intersection/coner of roads

UAV imagery classification

- Object oriented classification



Pixel based classification (ISODATA)



Object oriented classification

Object scale in training data sets

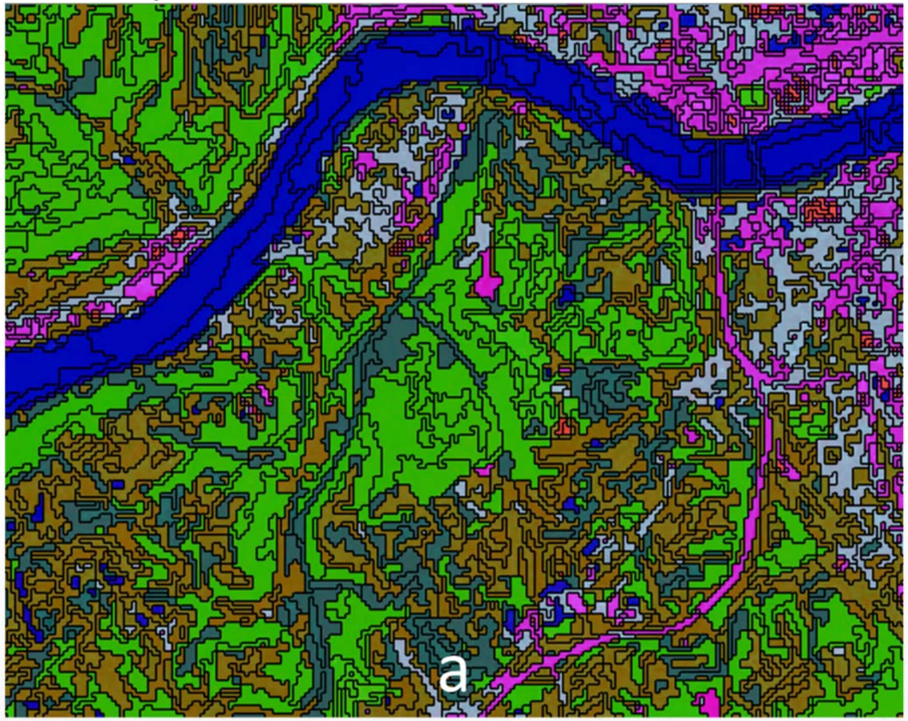
- Object oriented classification

Object scale 300

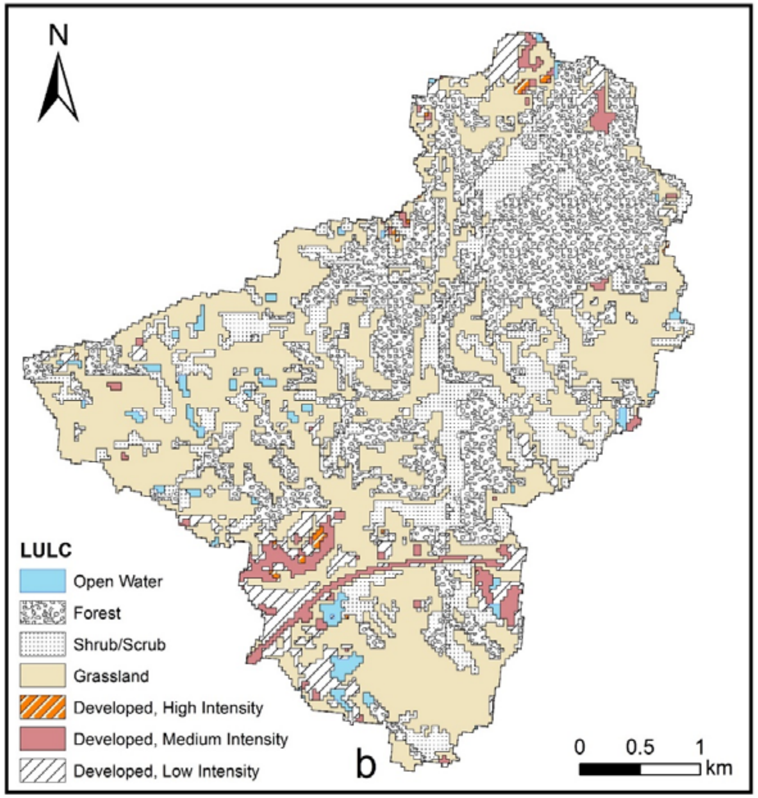
Object scale 200

UAV imagery classification

- Object oriented classification



object training samples



Object-oriented classification results

UAV Applications for seagrass

- **Seagrass standing crop**
- **Mangrove Leaf Area Index (LAI) and canopy closure**
- **Assessing of seagrass abundance**

Assessing Seagrass Standing Crop

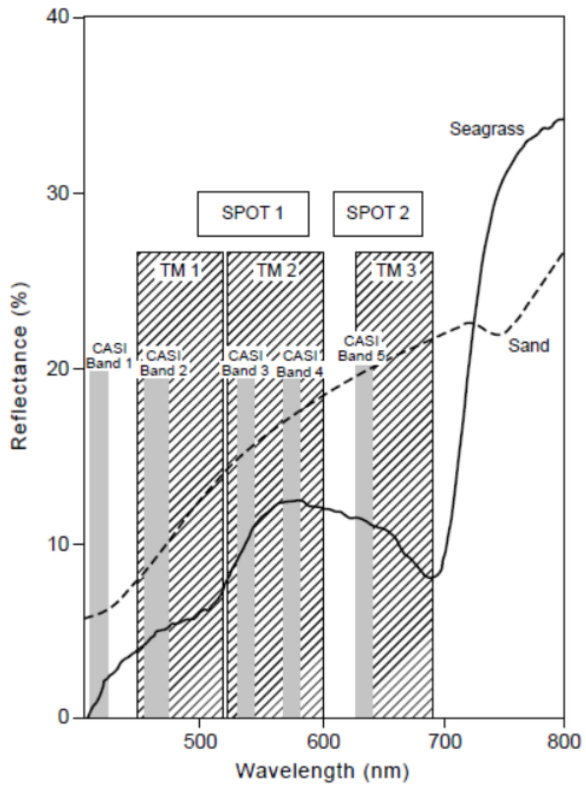


Figure 16.2 Spectral profile of sand and the seagrass *Thalassia testudinum* (epiphytes present) in relation to the spectral bands of remote sensing instruments. Spectral profile redrawn from Armstrong (1993).

Bands of 400–650 nm were designated in the region of the electromagnetic spectrum which best penetrates water

The choice of CASI bands is compared to a reflectance profile of the Caribbean seagrass Thalassia testudinum (Armstrong 1993).

Several of the bands have different reflectance characteristics for sand and seagrass which is necessary for discriminating seagrass bottom types using the water column correctionmethod.

Source: Green, E., Mumby, P., Edwards, A., & Clark, C. (2000). *Remote Sensing: Handbook for Tropical Coastal Management*. United Nations Educational, Scientific and Cultural Organization (UNESCO).

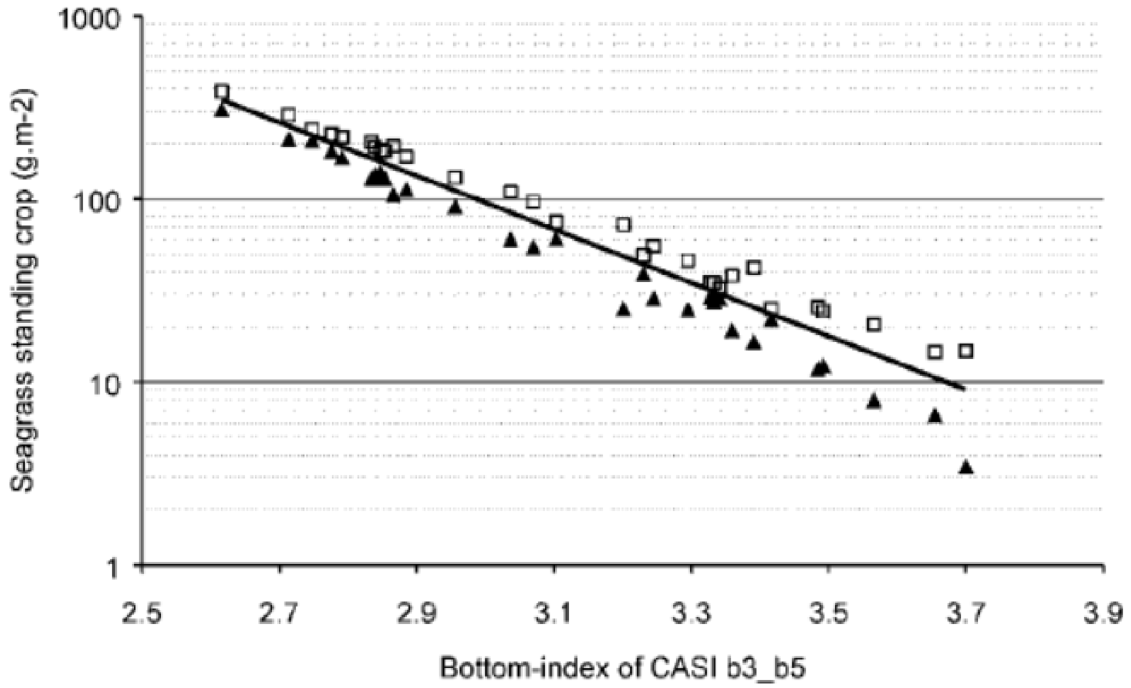


Figure 16.6 Regression of the logarithm of seagrass standing crop (g.m^{-2}) on processed CASI data (depth-invariant bottom-index generated from CASI bands 3 and 5) showing upper (□) and lower (▲) 95% confidence limits. Band 3 was set to 531.1–543.5 nm (green) and band 5 was set to 630.7–643.2 nm (red).

Source: Green, E., Mumby, P., Edwards, A., & Clark, C. (2000). *Remote Sensing: Handbook for Tropical Coastal Management*. United Nations Educational, Scientific and Cultural Organization (UNESCO).

Measurement of canopy transmittance and calculation of LAI

Canopy transmittance is given by the ratio I_c / I_o where I_c = light flux density beneath the canopy and I_o = light flux density outside the canopy. LAI can then be calculated, and corrected for the angle of the sun from the vertical, using the formula.

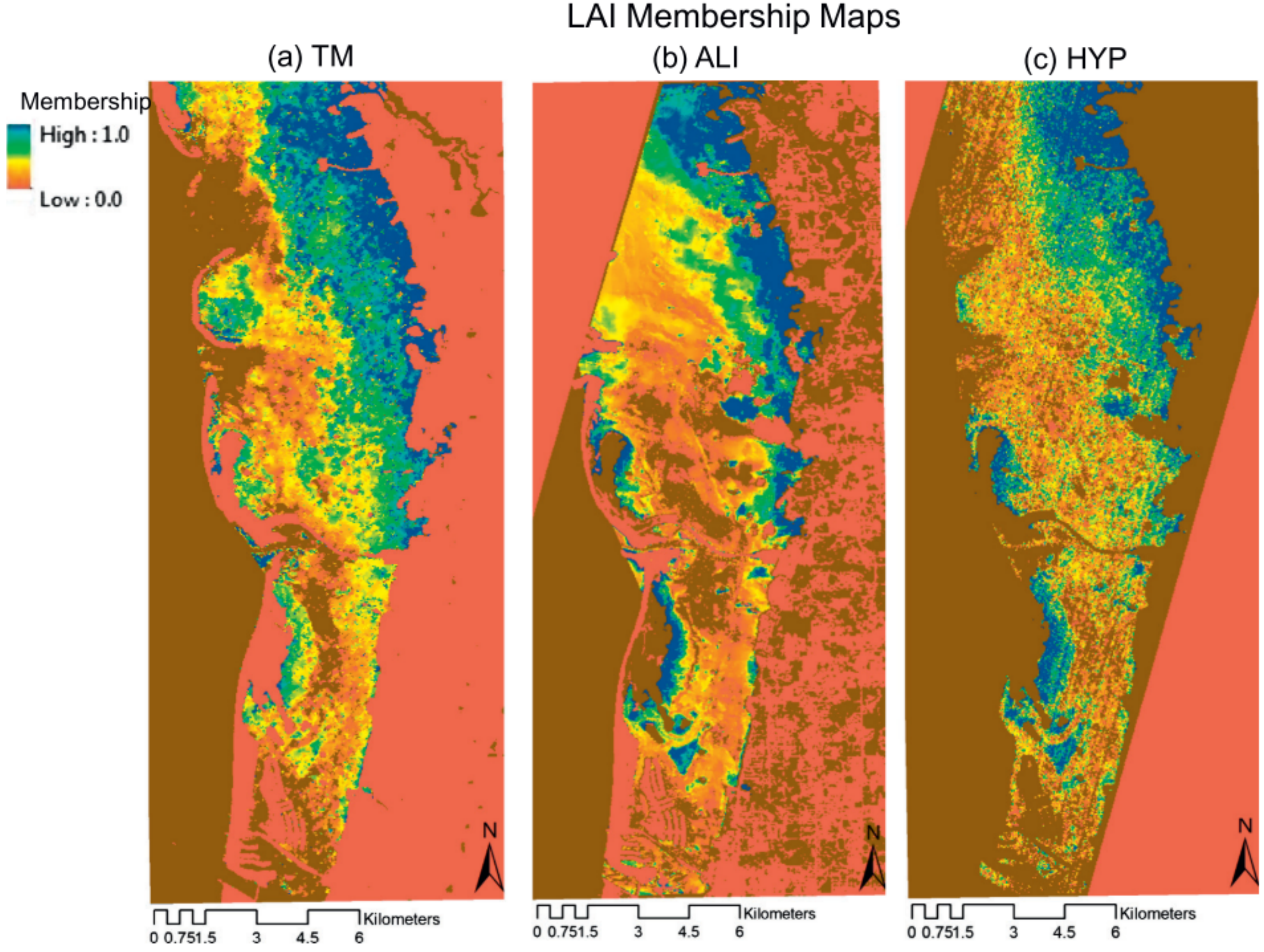
$$LAI = \frac{\log_e \left(\frac{I_c}{I_0}\right)}{k} \times \cos\theta$$

LAI = leaf area index, k = canopy light extinction coefficient, which is a function of the angle and spatial arrangement of the leaves.

Assessing of seagrass abundance

- Combining the calculation of NDVI, LAI and classification methods.
- Change detection,
- Two major components:
  - (1)image optimization and atmospheric correction preprocessing for detailed seagrass classification
  - (2) a fuzzy synthetic evaluation model for assessing seagrass abundance.

Assessing of seagrass abundance



LAI membership maps created using the three multiple regression models for LAI (Table 5) developed with data from the three sensors [TM (a), ALI (b), and HYP (c)] and field transect survey data

Source: Pu, R.; Bell, S. A protocol for improving mapping and assessing of seagrass abundance along the West Central Coast of Florida using Landsat TM and EO-1 ALI/Hyperion images. *ISPRS J. Photogramm. Remote Sens.* **2013**, *83*, 116–129.

GIS data sharing platform

- Open reef data sharing on ArcGIS online

http://ucfonline.maps.arcgis.com/home/item.html?id=a93efd6937a843e4b0fe513696c164f7

Outreach and community drone projects

Thanks for your attention!