UAV Imagery Assignment:

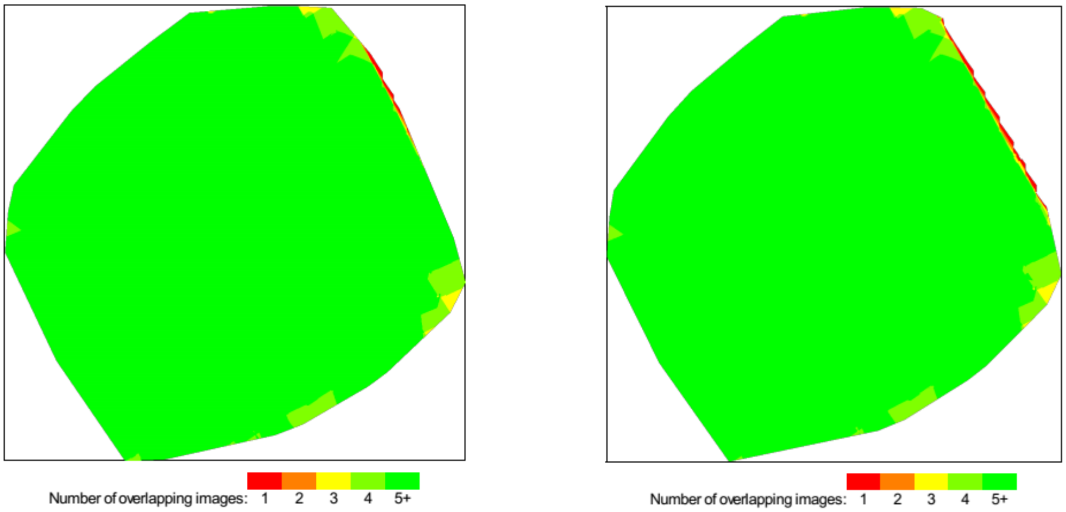
1. In Pix4D for initial processing use custom keypoint image scale and compare the final maps with image scale of 1(original image size) and 1/8. What happens when you reduce the image scale? You should check the quality report and compare both methods. For this task use the RGB images.
2. Which image scale you are recommending for a flight mission with low overlap. Explain your reason.
3. Generate the 3D model (Point cloud) for RGB images with and without GCPs and compare the quality report results. Is there any difference between overlap, 2D keypoints and uncertainty ellipses for both methods? If yes, please explain the difference.
4. Generate the 3D model for multispectral images and explain the differences in processing steps for RGB images and multispectral images.
5. Extract the crop plots using a polygon in QGIS as explained in the manual.
6. Explain 3 different vegetation indices including NDVI, MTCI, and EVI and generated the heat map of the field for each index based on the calculated values from QGIS. (heatmap visualization and could be done in R or Python).

Following you could see a sample report:

Sample report

RGB Map

A dataset counting 88 images collected using an RGB camera on a drone was stitched together in the trial version of Pix4D using a settings profile that favored speed over quality of results. A quality report was generated after the initial processing of the input data, both prior to and after the adding of three Ground Control Points (GCPs) and 13 Manual Tie Points (MTPs), where the MTPs were all anchored to the GCPs visible in the input images.
The differences in overlap between the two quality reports can be seen below. The main difference between the two is that the addition of GCPs seems to have decreased the overlap in the right border of the map.



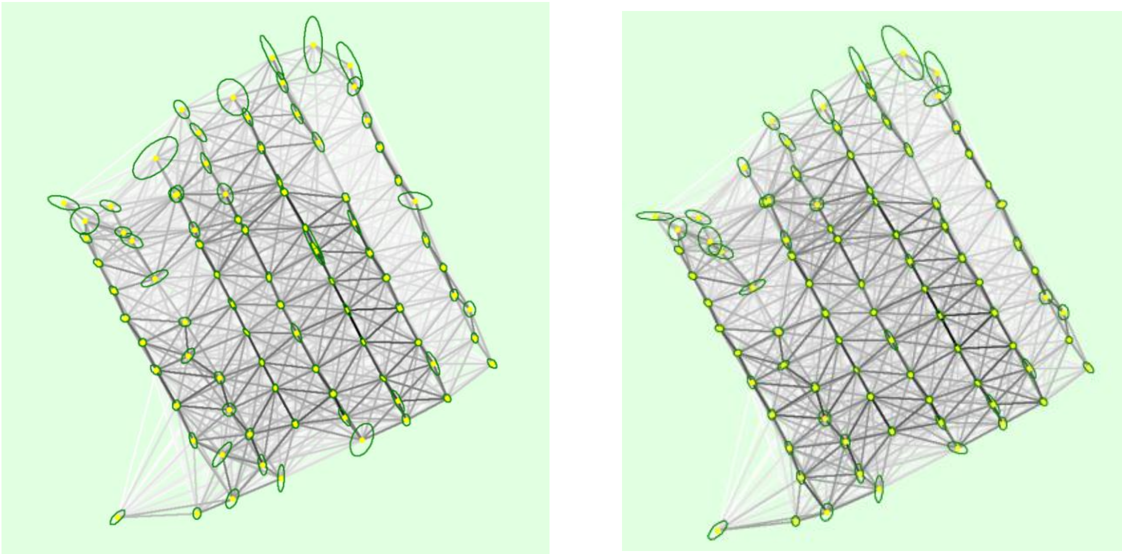
Overlap diagram before (left) and after (right) adding GCPs and MTPs.

The 2D keypoint tables reveal that adding GCPs led to an increase of matched 2D keypoints per image across all the summary statistics. A decrease in the size of uncertainty ellipses for the 2D keypoint matches can also be observed when GCPs were added.

2D keypoint table before (top) and after (bottom) adding GCPs

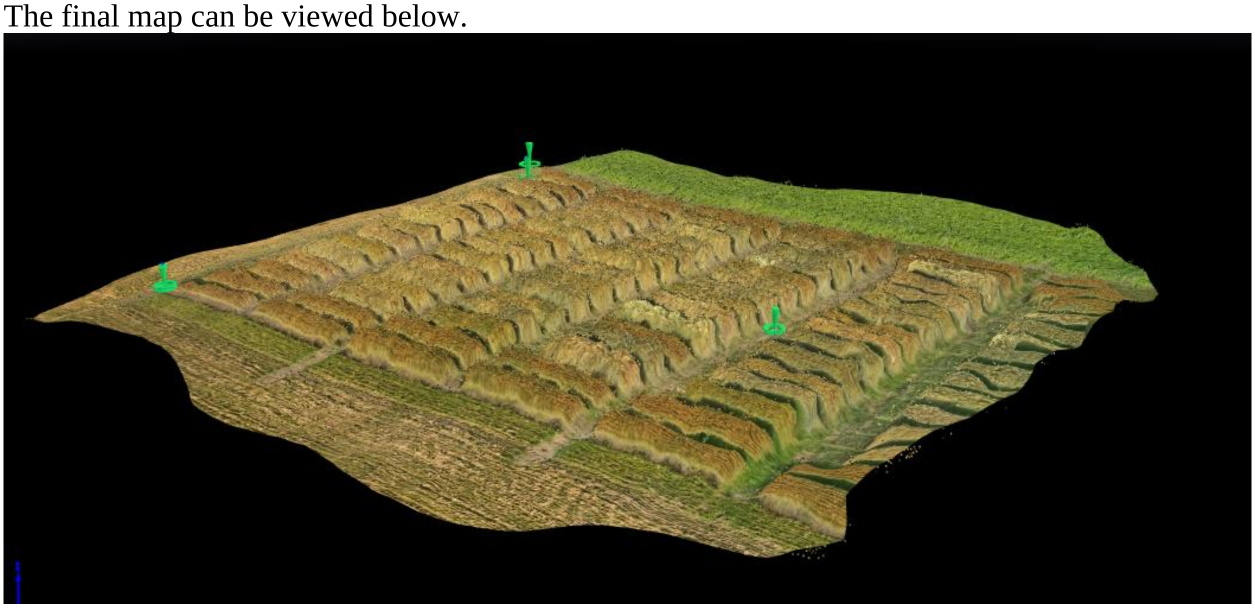
	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	591	290
Min	323	115
Max	749	396
Mean	570	272

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	591	337
Min	323	130
Max	749	438
Mean	570	308



2D keypoint uncertainty ellipses before (left) and after (right) adding GCPs.

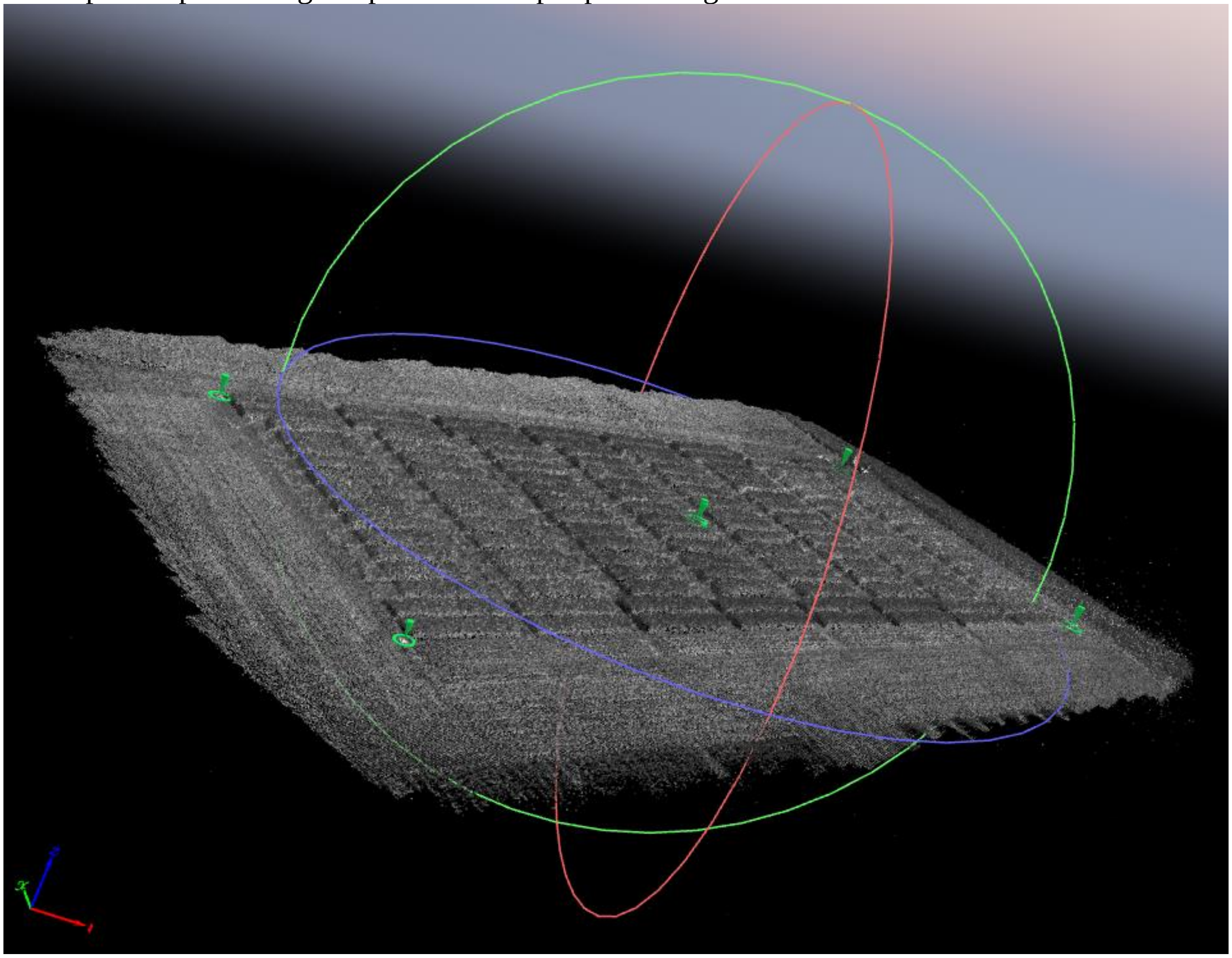
In summary, adding GCPs reduced the overlap in the border area of the generated map, while increasing the accuracy of 2D keypoint matches.
The final map can be viewed below.



NIR Map

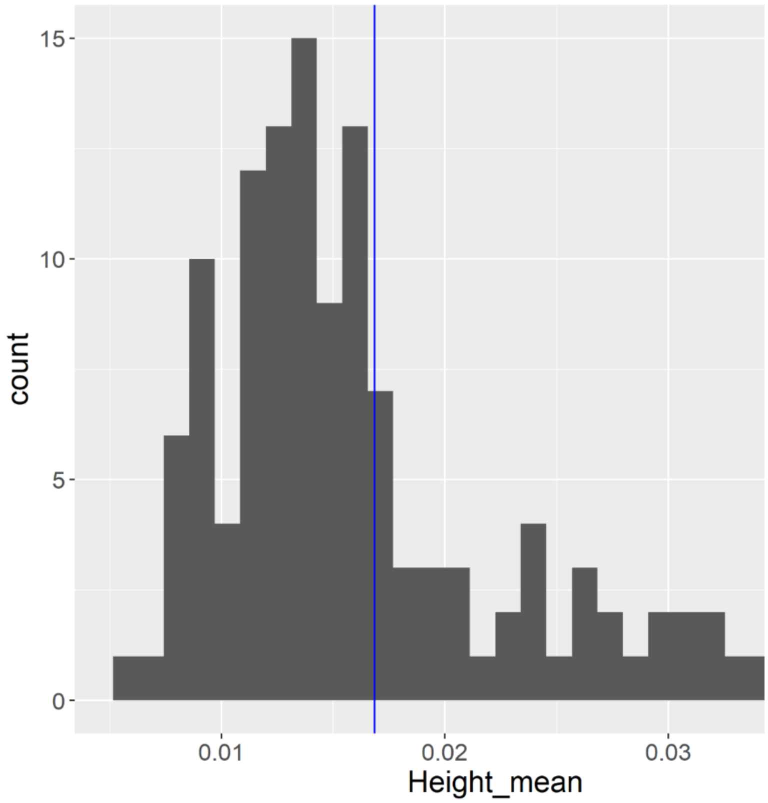
The main difference of multispectral image data, compared to the RGB, is that in addition to red, blue and green bands, we have data collected in the near-infrared (NIR) and red-edge bands. Data from each band is collected in separate image files. The availability of NIR data and the separation of bands into their own files means that it is possible to calculate interesting spectral vegetation indices (SVIs). SVIs are linear combination of two or more spectral bands that are sensitive to some property of vegetation. One example is the Normalized Difference Vegetation Index, which uses reflectance data collected in the Red and NIR spectral bands to quantify green vegetation. Another difference compared to RGB image data processing is that MTPs need to be marked out in images from all the spectral bands. Furthermore, in order to obtain reliable spectral reflectance data, radiometric calibration of the multispectral sensor needs to be performed against a white reflectance reference plate. To put it simply, the reflectance at each band is calibrated against a measurement of reflectance collected from a reference plate at the beginning or end of a flight.

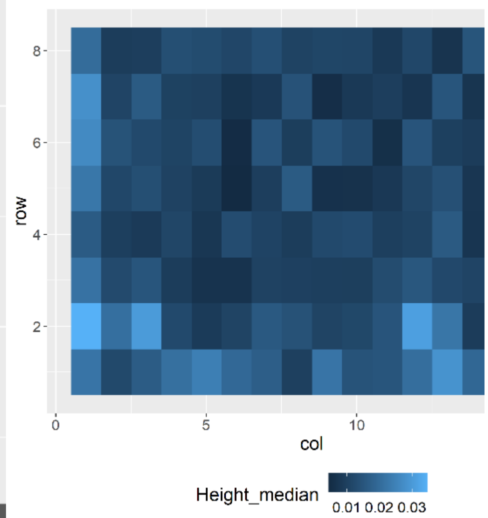
A point cloud (pictured below) was generated from 3215 image files in PIX4D using the Ag Multispectral processing template set to rapid processing. Five MTPs were added.



QGIS Height map

QGis 3 was used to calculate the height for each plot in a field trial. A Digital Terrain Model was subtracted from a Digital Surface Model. The plots were delineated manually and the mean and median height was extracted from each plot. The distribution of mean height and the spatial distribution of median height can be seen below.

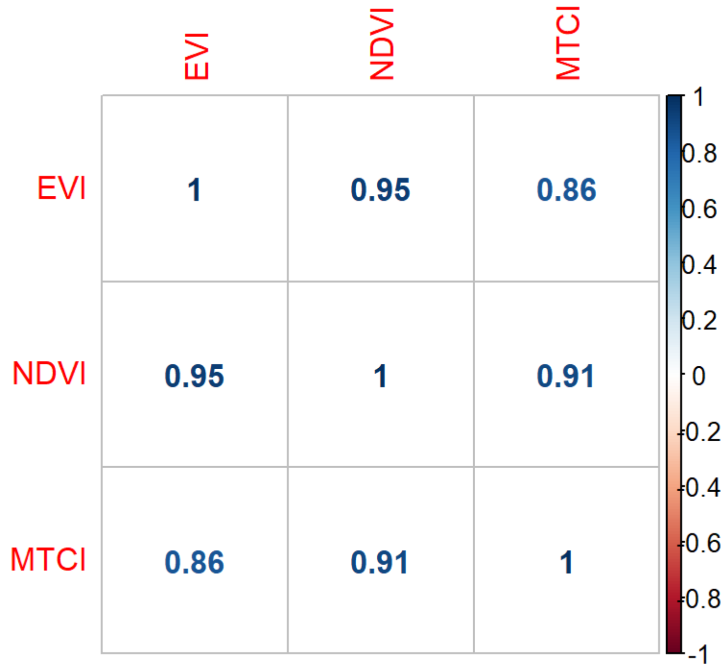




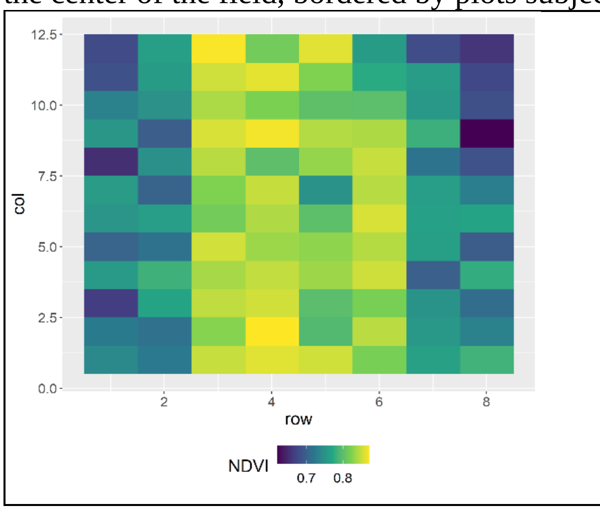
Mean hei

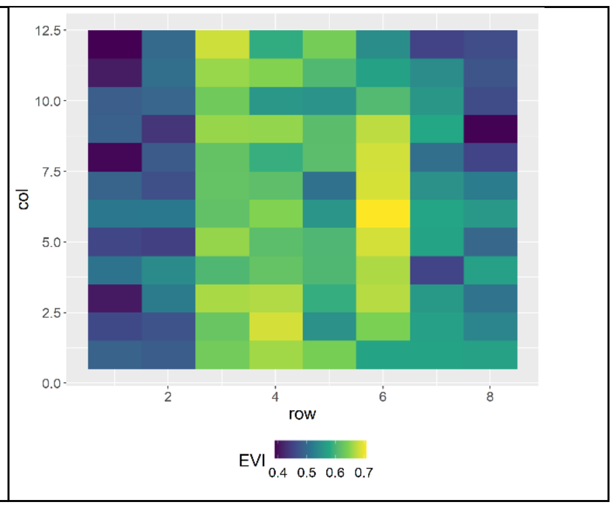
QGIS indices

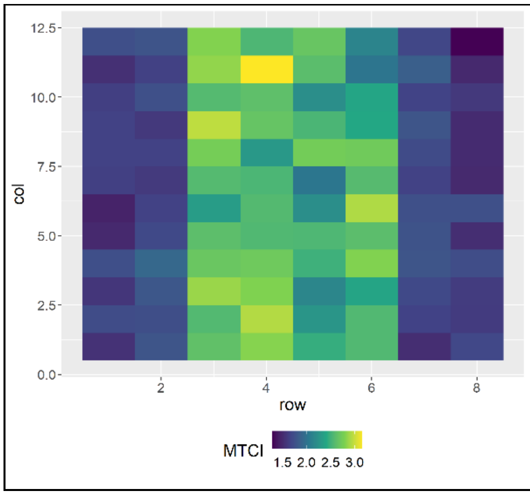
Threee SVIs—NDVI, Meeris MERIS terrestrial chlorophyll index (MTCI) and Enhanced vegetation index EVI—were calculated for each plot in a multispectral dataset collected in a wheat field trial. The indices are highly correlated with each other, as seen in the correlation plot below, which was calculated on the extracted plot data. NDVI and EVI are both designed to quantify vegetation in remote sensing data. EVI improves on NDVI by—at least in satellite data—correcting for atmospheric conditions, in addition to being more robust to structural variation in canopies. NDVI uses reflectance in the NIR and Red spectral bands, whereas EVI uses both of these bands in addition to data in the Blue spectrum. MTCI uses data in the Red, NIR, and Red-edge bands to estimate chlorophyll content—it is the least correlated to both NDVI and EVI.



Below are the heatmaps generated from the SVI data. In all the heatmaps, brighter colors denote higher index values, suggesting higher chlorophyll content. The pattern of more green center rows corresponds to the two fertilizer treatments used in the data. The high fertilizer cohort is in the center of the field, bordered by plots subjected to low fertilizer levels.







Modelling MTCI in response to fertilizer treatment and variety