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Case study of use of different source of imageries and data fusion

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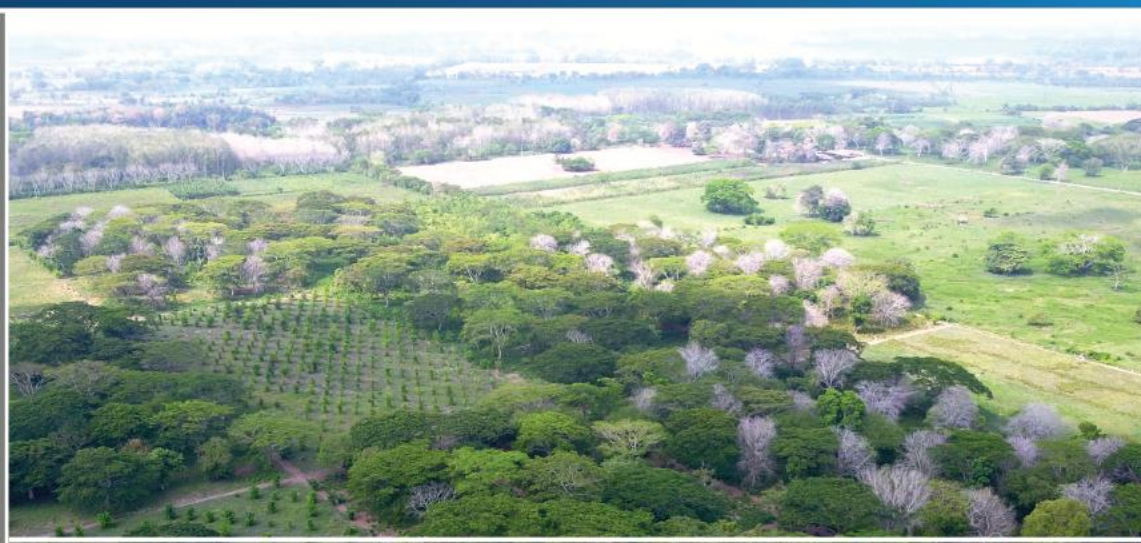

CGIAR RESEARCH PROGRAM ON Livestock

ICARDA
Science for resilient livelihoods in dry areas

Case study of use of different source of imageries and data fusion

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Rationale

Currently, there are a number of tools aimed to deploy remotely responses such as vigor in pastures and grasslands. Amon existing tools for gathering of information are satellites and Unmanned Aerial Systems (UAS). From both satellite and UAS, a number of sensors can be mounted to collect multispectral images covering the ranges from visible to near infrared light. Multispectral images can be used to calculate different plant vigor indexes such as NDVI (Normalized Difference Vegetation Index). Nowadays, NDVI is probably the most common vegetation index. Values of NDVI close to 0 ,represent mostly bare soil or very low vegetation, whereas values close to 1 represent vigorous plants (green and vigorous plants).

Methods and results

The following work was therefore to compare NDVI calculated from satellite (Sentinel-2), which offers a resolution of up to 10 m/pixel and a revisit time of six days with that of NDVI collected from a UAS (Phantom IV mounted with modified cameras collecting information on different bands of visible and Near Infraded light spectrum). For that we used images collected weekly with the aforementioned UAS from June 2017 to January 2020 to a 6 ha Silvopastorial trial [76.3476172023341,3.503036565400138] located at the Alliance of Bioversity International-International center for Tropical Agriculture, Americas Hub). The trial is divided in six different subplot, each of 0.33 ha. The size of the trial and each subplot makes this trial ideal for a comparisons of information gathered from Sentinel-2 and UAS.

We used Google Earth Engine to visualize and analyze satellite data as described in the below links:

- https://hdl.handle.net/10568/106827
- https://hdl.handle.net/10568/106852

For collection of images collected we followed what previously described in:

- https://hdl.handle.net/10568/106851

NDVI was then calculated for the UAS images. Previous work was performed to test the accuracy of remotely sensed information form UAS and on the ground measurements of NDVI using an active and on the ground NDVI sensor (Greenseeker) (Figure 1). Correlation between NDVI remotely sensed and NDVI from Greenseeker was high ($R^2 < 0.8$, RMSE ~ 0.1)

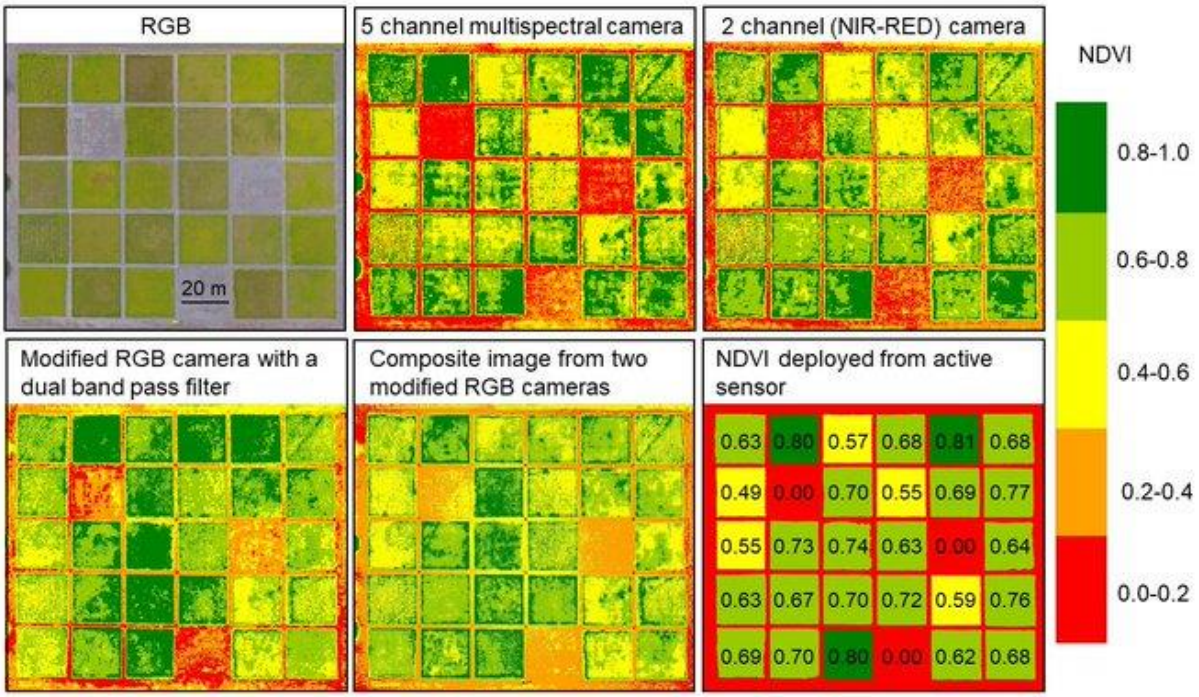

Figure 1. Relationship between UAS and on the ground measurements of NDVI.

In GEE, we looked for images that were free of clouds through the period of June 2017 to January 2020. Those images were selected to compare NDVI collected from both Sentinel-2 and UAS (Table 1 and Figure 2).

Table 1. Dates selected to perform comparisons for NDVI values calculated form Satellite (Sentinel-2) and UAS

Date	Sentinel-2	UAS	Difference in days (+-)
1	2017-07-16	2019-07-18	2
2	2017-09-14	2019-09-12	2
3	2017-11-08	2019-11-12	4
4	2019-11-28	2019-12-02	5
5	2020-01-07	2020-01-04	3
6	2020-01-17	2020-01-15	2

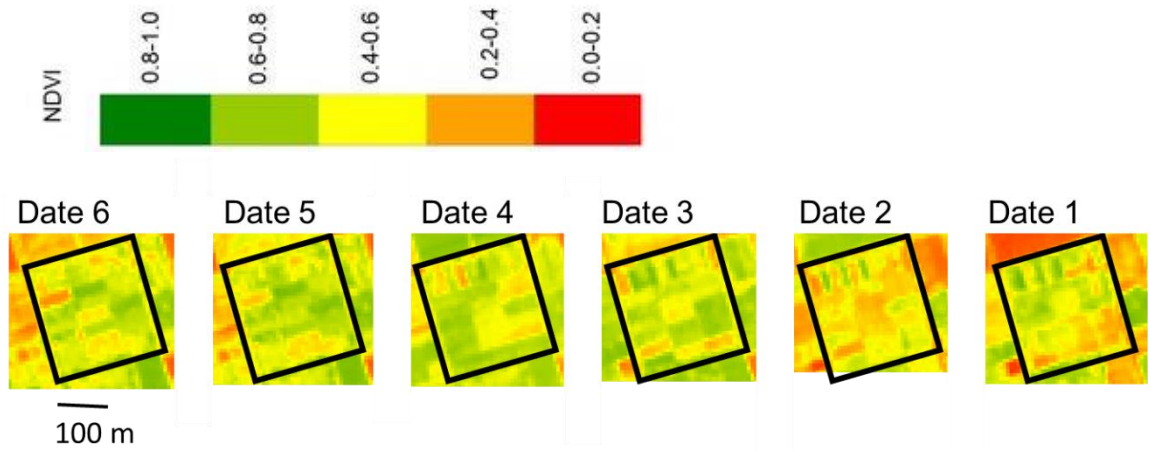

Figure 2. Cloud free images collected form Sentinel-2 to compare to those obtained form UAS

Overall, the results show that NDVI remotely sensed data from Satellite was underestimated when compared to that of UAS. However, there was a high correlation (Figure 3 and 4) and a RMSE=0.1.

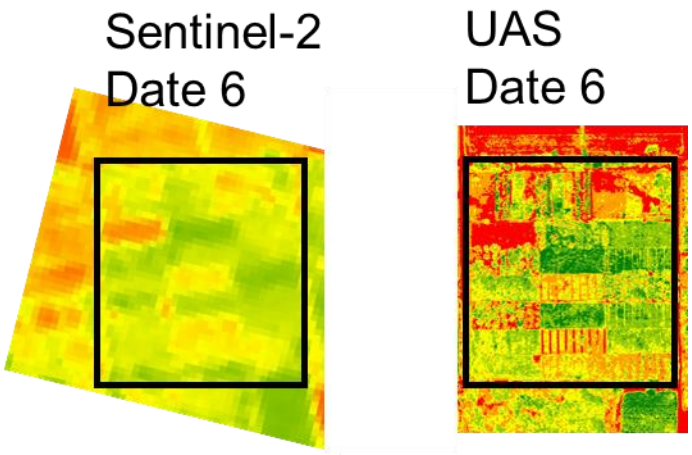

Figure 3. Visual differences of NDVI deployed from Sentinel-2 and UAS on 17th, January, 2020.

Overall, the results show that NDVI remotely sensed data from Satellite was underestimated when compared to that of UAS. However, there was a high correlation (Figure 3 and 4) and a RMSE=0.1

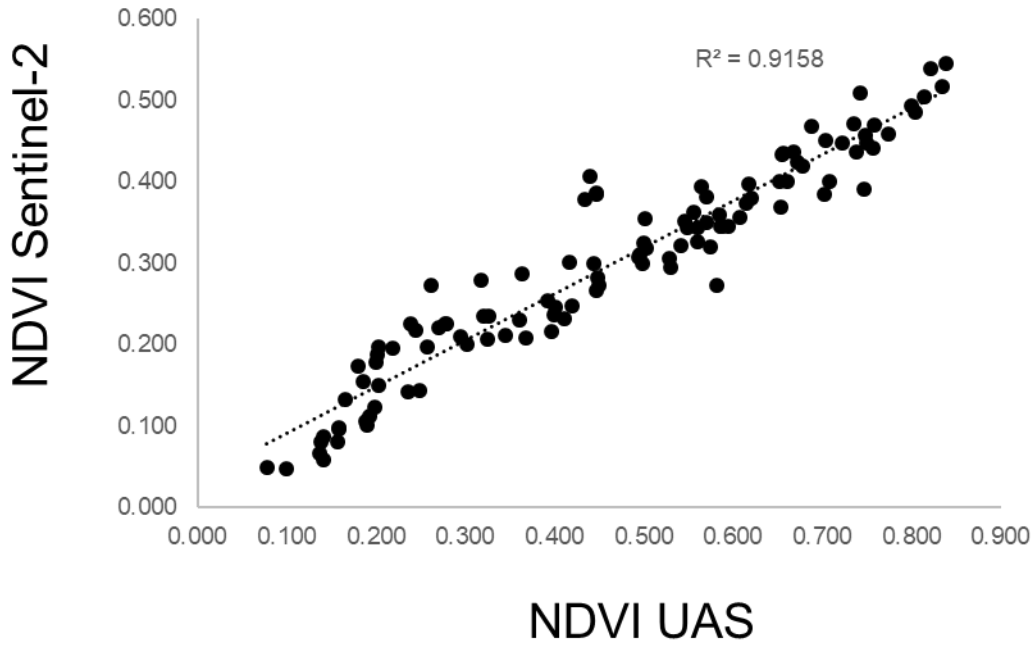

Figure 4. Correlation between NDVI deployed from Sentinel-2 and UAS over six different dates.

Conclusions

The present work showed that NDVI deployed form Sentinel -2 was underestimated but showed notheless high correlation and a relatively low error compared to that of UAS. NDVI calculated from satellite and UAS can be used in large areas, where manual recording of pastures vigor is not possible or logistically difficult. The presence of clouds in a large number of Sentinel-2 images indicates that other methods to estimate remotely vigor of plants, such a SAR (synthetic aperture radar) must be taken into consideration. Data fusion of both sources of images are the next step into consideration. Originally, SATRM was intended to be used, but was dropped due to technical inexperience on the subject. It is intended to keep experimenting based on sensor data fusion but using Support Vector Machines.

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