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Data Article

# A dataset of unmanned aerial vehicle multispectral images acquired over a field to identify nitrogen requirements

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ABSTRACT

The technique of detecting and tracking an area's physical properties from a distance by measuring its reflected and emitted radiation is known as remote sensing. It gathered data accurately in near real-time. For this purpose, multi-spectral cameras mounted on UAVs that capture images with different bands can be used to generate vegetation indexes (NDVI, NDRE), which are useful in precision agriculture. In this study UAV image dataset contains 336 multispectral images from a 0.06 ha paddy field with three different phonological cycles of the crop (vegetative, reproductive, and ripening) in the north-western province of Sri Lanka. The selected sample rice variety is BG300. The images were taken over five days, starting from August 14 to October 5, 2023. The UAV flight took place at 30 m from the canopy level with the multispectral camera titled at an angle of 900. The SPAD Chlorophyll Meter was used to collect ground truth data, which is proportional to the nitrogen level of the leaf. There were 50 randomly selected readings throughout the paddy field. Relevant climate data for five days was provided by the Rice Research and Development Institute, Bathalagoda, which belongs to the paddy field. The purpose of this data creation was to aid researchers who are generally interested in disease diagnosis. Moreover, this dataset allows for studying the

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effect of using different tilt angles on the 3D reconstruction of the paddy fields and the generation of orthomosaics.



Specifications Table

| | |
|---|---|
| Subject | Human-Computer Interaction, Artificial Intelligence, Agriculture |
| Specific subject area | Identification on Nitrogen requirement in Paddy farms using UAVs |
| Type of data | Multispectral Image, SPAD meter reading |
| Methods of obtaining the data | UAV data<br>Aerial Platform: DJI Mavic 3 M<br>Flight Speed: 1.5 m/s<br>Overlap: Side - 70 %<br>Front End - 80 %<br>Flight Altitude: 30 m<br>Sensor: 1/2.8-inch CMOS, effective pixels: 5 MP<br>RGB Camera: 20MP, 4/3 CMOS<br>Multispectral Camera Band:<br>Green (G): 560 ± 16 nm;<br>Red (R): 650 ± 16 nm;<br>Red Edge (RE): 730 ± 16 nm;<br>Near infrared (NIR): 860 ± 26 nm;<br>Sensor characteristics: Shutter Speed [1:2000],<br>Shooting time interval 3 second<br>SPAD meter data<br>Meter Type: Chlorophyll Meter SPAD-502Plus<br>Measurement subject: Crop leaves<br>Measurement method: Optical density difference at 2 wavelengths<br>Measurement area: 2 mm × 3 mm<br>Subject thickness: 1.2 mm maximum<br>Light source: 2 LED elements |
| Data format | Raw |
| Rice verity | BG300 |
| Description of data collection | The data was based on three (03) phonological cycles of the crop (July–Oct).<br>1. vegetative (V)<br>2. reproductive (R)<br>3. Ripening (Ri)<br>On August 14, 28, September 6, 19, and October 5, 2023, UAV flights were conducted at the 30 m height from the canopy level. According to the manufacturer's instructions, the flight path was configured to fly on its own (DJI). The dataset includes a shapefile containing the GPS positions of the BG300 rice clusters. The same dates were used to gather SPAD meter values. |
| Data accessibility | Repository name: Mendeley Data<br>Data identification number: 10.17632/h8s5mn52j6.1<br>Direct URL to data: https://data.mendeley.com/datasets/h8s5mn52j6/1 |
| Data source location | Institution: Rice Research and Development Institute<br>City/Town/Region: Batalagoda, Ibbagamuwa, Kurunegala<br>Country: Sri Lanaka<br>Latitude and longitude (and GPS coordinates) for collected samples/data: 7.53240 N, 80.43400E |

## 1. Value of the Data

- Data is useful for researchers interested in UAV (unmanned aerial vehicle) remote sensing in Paddy crops. Moreover, it allows digital photogrammetry and 3D reconstruction in the context of precision agriculture.

- This dataset allows studying the effect of using different tilt angles on the 3D reconstruction of the paddy fields and the generation of orthomosaics.
- The data can be employed to develop new vegetation indices and algorithms for disease detection in Paddy fields.
- The association between the spectral information of the vegetation and the health state of the plants may be studied using the dataset.
- Dataset can be utilized as a resource for image segmentation and allows the development of new techniques for trunk detection, plant isolation and vegetation segmentation in agriculture.
- Utilizing the dataset, one may construct multispectral thick clouds and extract more information beyond what can be found in a single orthomosaic.

## 2. Background

This dataset was compiled to support research aimed at identifying the nitrogen requirements of paddy fields using UAV-based aerial imagery. The motivation behind collecting these multispectral images stems from the need to address challenges in precision agriculture, particularly in optimizing nitrogen management for paddy cultivation.

The dataset comprises multispectral images of paddy fields (BG300) captured during three distinct crop phonological cycles from July to October 2023. Five flights were conducted on various days to ensure sufficient variability across different growth stages of the crops.

*The primary objectives of collecting these images were as follows:*

- To facilitate the study of the impact of adjusting imaging parameters on vegetation segmentation and identification.
- To enable the use of UAV imagery for the detection of nitrogen levels in paddy fields.
- To provide data for studies aimed at estimating the nitrogen requirements for paddy cultivation.

*The creation of vegetation indices and orthomosaics from these multispectral images further enhances the utility of the dataset for researchers in the field of precision agriculture.*

## 3. Data Description

This work describes a set of ground data collected from the Chlorophyll Meter (SPAD-502Plus) and five flights over a paddy field (7.53240 N, 80.43400E) property of ‘Rice Research and Development Institute’, located in Batalagoda, Ibbagamuwa, within the Kurunegala, Sri Lanka region. The fieldwork, conducted between the wet period, from July to October. The paddy field is the flights were made using DJI Mavic 3 M teleoperated compact quadcopter drones (Fig. 1) for personal and commercial aerial photography and videography use, and a multispectral sensor (5.5 MP single-band cameras and one 20 MP RGB camera). The Mavic 3 M [1,2] comes with an RTK module, enabling experts in agriculture to carry out precise flying surveys with caution, effectiveness, and most importantly without the requirement for Ground Control Points (GCPs). On June 20, 2023, over a 0.06-hectare area, BG300 rice plants were planted with an 8-inch plant-to-plant spacing. An initial application of 22 kg of TSP fertilizer was made per acre.

### *3.1. UAV multispectral data*

There are 336 multispectral images in this dataset. Table 1 shows the number of aerial photographs taken per flight. Each shot of the multispectral camera captures four bands

**Fig. 1.** DJI Mavic 3 M teleoperated compact quadcopter drone.

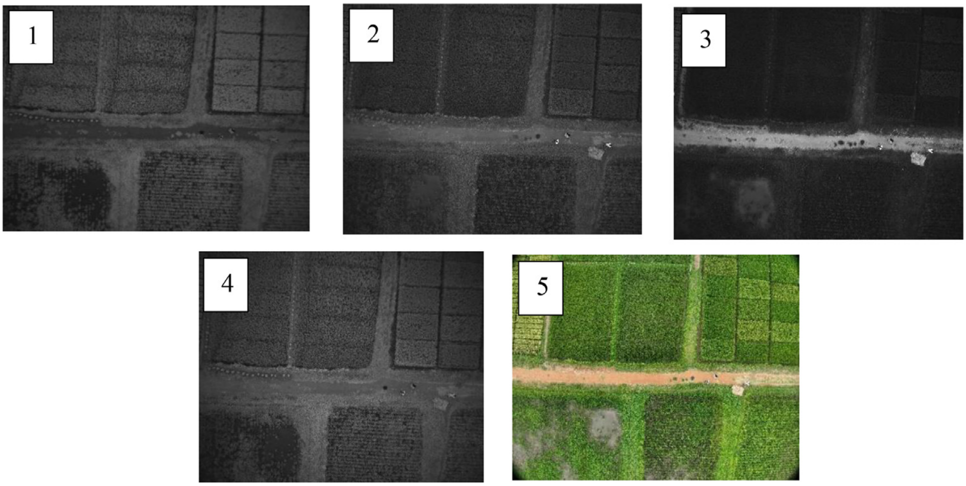


**Fig. 2.** Multispectral imagery & RGB image taken at 30 m. 1. green, 2: near-infrared, 3: red, 4: red edge and 5: RGB image.

**Table 1**
Number of Images taken per flight. Total Images 416.

| Flight number | Date | No. of images | |
|---|---|---|---|
| | | RGB | Multispectral |
| 1 | 14/08/2023 | 17 | 68 |
| 2 | 28/08/2023 | 16 | 64 |
| 3 | 06/09/2023 | 17 | 68 |
| 4 | 19/09/2023 | 17 | 68 |
| 5 | 05/10/2023 | 17 | 68 |

(green, red, red edge, and near-infrared) with RGB image in separated JPG (Joint Photographic Experts Group) files (Fig. 2). Table 2 shows the band number, name, and wavelength (nm) of each band, according to the specifications provided by the manufacturer. 20MP, 4/3 CMOS RGB camera captures the RGB images. The names of the multispectral images are organized as "DJI_DateTime_imgNumber_MS_bandNumber". For example, "DJI_20,230,814,123,320_0001_MS_G" is band 1 (green) of image number 001 of the flight on August 14, 2023, at 12.33.20 p.m. and "DJI_20,231,005,124,002_0001_D" is RGB image number 001 of the flight on October 05, 2023, at 12.40.02 p.m.

**Table 2**
DJI Mavic 3 M multispectral camera band.

| Band number | Band Name | Bandwidth |
|---|---|---|
| 1 | Green | 560 ± 16 nm |
| 2 | Red | 650 ± 16 nm |
| 3 | Red Edge | 730 ± 16 nm |
| 4 | Near infrared | 860 ± 26 nm |

**Table 3**
SPAD meter readings.

| Date | Readings | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 |
| 14/08/2023 | 38.7 | 41.5 | 34.8 | 35.8 | 36.6 | 34.9 | 37.4 | 36.8 | 40 | 36.8 |
| 28/08/2023 | 44.4 | 39.4 | 40.5 | 40.8 | 40.3 | 38.5 | 43.8 | 38.2 | 35.4 | 36.8 |
| 06/09/2023 | 39.9 | 27.8 | 38.5 | 43.8 | 37.2 | 34.5 | 35.8 | 36.6 | 36.8 | 39.1 |
| 19/09/2023 | 36 | 37.1 | 39 | 36.9 | 39.9 | 27.8 | 35 | 55.5 | 39 | 34.8 |
| 05/10/2023 | 18.1 | 1.9 | 19.9 | 12.1 | 15.6 | 11.2 | 12.6 | 12.4 | 10.3 | 12.6 |

**Table 4**
Climate data.

| Date | | 14/08/2023 | 28/08/2023 | 6/9/2023 | 19/09/2023 | 5/10/2023 |
|---|---|---|---|---|---|---|
| Average | Max | 32.6 | 33.6 | 28.6 | 29.5 | 28.5 |
| Temperature | Min | 21.9 | 23.9 | 22.9 | 21.5 | 23.5 |
| Average | Morning | 71 | 74 | 92 | 81 | 77 |
| Humidity | Evening | 55 | 51 | 81 | 84 | 88 |
| Average Wind | | 5.8 | 7.9 | 5.7 | 5.4 | 3.8 |

### *3.2. Ground-truth data*

The leaf's chlorophyll content is correlated with the reading from the SPAD meter. On a scale ranging from −9.9 to 199.9, it instantaneously determines the plants' chlorophyll level or "greenness." As 10 sample data points every day throughout the field, SPAD-502 Plus Meter randomly gathered 50 measurements over the course of five days. Table 3 shows the number of SPAD readings taken per day.

### *3.3. Climate data*

In addition to the multispectral data and ground truth data we also collected climate data including average temperature, average humidity, and average wind. The climate data in relevant days is displayed in Table 4.

## 4. Experimental Design, Materials and Methods

### *4.1. UAV multispectral data*

The study involved five different days and five UAV flights at a height of thirty meters. The flights encompassed three distinct phonological cycles, namely the vegetative (V), reproductive (R), and ripening (Ri) stages. The camera was 90° angled during the flight. The frontal overlap was 80 % and the side overlap was 70 % as expected. The position of the images over the paddy field during the trip is illustrated in Fig. 3 (green dots) and the Orthomosaic map

**Fig. 3.** Location of the geotagged images. Green dots are the location of the images over the paddy field in the first flight. The background Orthomosaic was created using the RAW images provided in this dataset.

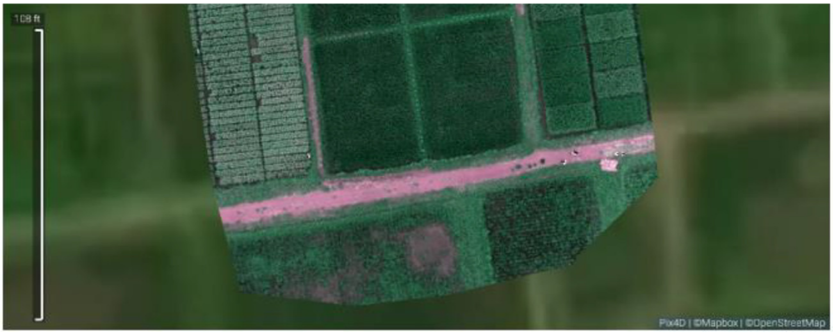


**Fig. 4.** Orthomasaic map.

generated using Pix4D over the paddy field in the first flight is presented in Fig. 4 The manufacturer's instructions were followed while programming the flight path to fly autonomously (DJI). The official “DJI Pilot” app was used to plan the operation in order to guarantee a safe flight and adequate overlap coverage. During the first two days of the airborne survey, the sky was clear with a few isolated clouds; on the final three days, the sky was covered in rain clouds. The multispectral camera features 5 MP effective pixels in the following bands: 860 ± 26 nm near infrared (NIR), 650 ± 16 nm for red (R), 730 ± 16 nm for red edge (RE), and 560 ± 16 nm for green (G). There are 20 MP of useful pixels in the RGB camera. Other features include the following: shutter speed of 1/2000, interval shooting time of 3 s, focal aperture of f2.0 (multispectral camera), and focal aperture of f/2.8 to f/11 (RGB camera). The RGB camera in JPEG format and the multispectral camera in TIFF format automatically geotagged every image. These sensors give farmers essential information by supporting the NDVI, GNDVI, and NDRE vegetation indices.


**Fig. 5.** SPAD-502 Plus chlorophyll meter and the reading checker.

### 4.2. Ground-truth data

The red and near-infrared absorbances of leaves are measured with the SPAD-502 Plus chlorophyll meter (Fig. 5). In less than two seconds, the meter uses these two absorbances to generate a numerical number that corresponds to the amount of nitrogen and chlorophyll in the leaf [3]. Each time the meter is turned on, calibration is required. Clamp the measuring heads together while the meter is empty to calibrate it. Utilizing the provided sample chip (reading checker), compare the resultant reading to the sample chip's indicated value. The meter is prepared to receive readings if the values match. We selected the 2/3 point on the paddy leaf because it was the most appropriate spot to estimate the nitrogen status of rice based on the literature [4].

## Limitations

- The data set is collected from a specific region, and its applications may be limited to others geographical areas with different fertilizer applications and climate impacts.
- Weather-related issues might affect drone flights and cause delays or obstructions in the collecting of data. Wind, rain, and extremely high or low temperatures might affect the quality of collected data and provide safety hazards.
- Drones can only cover a few square kilometers in a single trip due to their restricted flying range. To get thorough data for large agricultural areas, it may require several flights, which is a time-consuming operation.

## Ethics Statement

The present study does not involve human subjects, animal trials, or data gathered from social media sites, as all of the authors have read and complied with the ethical standards for publication in Data in Brief.

## Data Availability

Multispectral Images on Paddy- Sri Lanka (Original data) (Mendeley Data).

## CRediT Author Statement

**C.L.I.S. Fonseka:** Formal analysis, Investigation, Writing – original draft; **Thilina Halloluwa:** Conceptualization, Methodology, Writing – review & editing; **K.P. Hewagamage:** Investigation, Supervision, Writing – review & editing; **Upul Rathnayake:** Data curation, Formal analysis, Visualization, Writing – review & editing; **R.M.U. S Bandara:** Data curation, Supervision.

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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