remote sensing

MDPI

Supplementary Materials:

Remotely Piloted Aircraft Systems multispectral data to evaluate the effect of prescribed burns in three macrohabitats of Pantanal, Brazil

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Multispectral sensor features

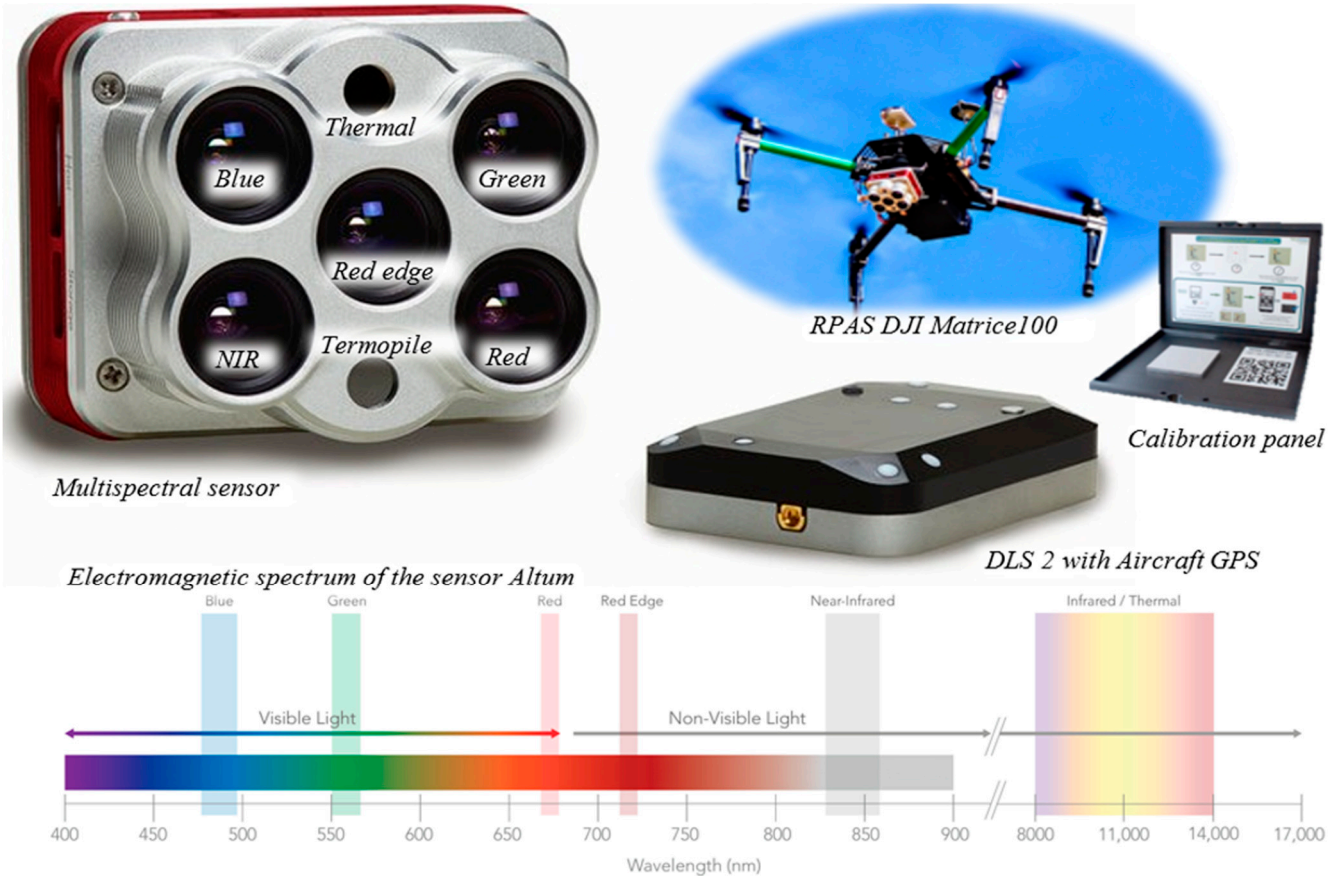


Figure S1. Attribute description of the features and electromagnetic spectrum of the MicaSense Altum multispectral sensor and RPAS.

Tasks carried out in the field work of prescribed burns

Prescribed burn fieldwork

The following describes the activities performed in the field during the prescribed burning phase in the SESC Pantanal RPPN; which can be cited in 8 phases mentioned below.

1) Flight Planning.
2) Checking weather conditions and calibrating the drone.
3) Verifying vegetation cover physiognomies.
4) Drone flight execution (pre-fire).
5) PBs in analysis plots.
6) Burn control by the technical team.
7) Execution of drone flight (post-fire)
8) Verification of the burning in late plots.

1. Flight Planning

Before the start of the drone flights, flight plans were made with the Mission HUB platform of the LITICHI software, for the total coverage of the three experimental areas of the evaluated macrohabitats with the total coverage of the control, early, mid, and late burning plots; with flight parameters with a height from the ground of 120 meters, with a speed of 10 m/sec and longitudinal and lateral coverage of 80%, as the duration of approximately 40 - 44 minutes each flight for total macrohabitat coverage (**Figure S2**)

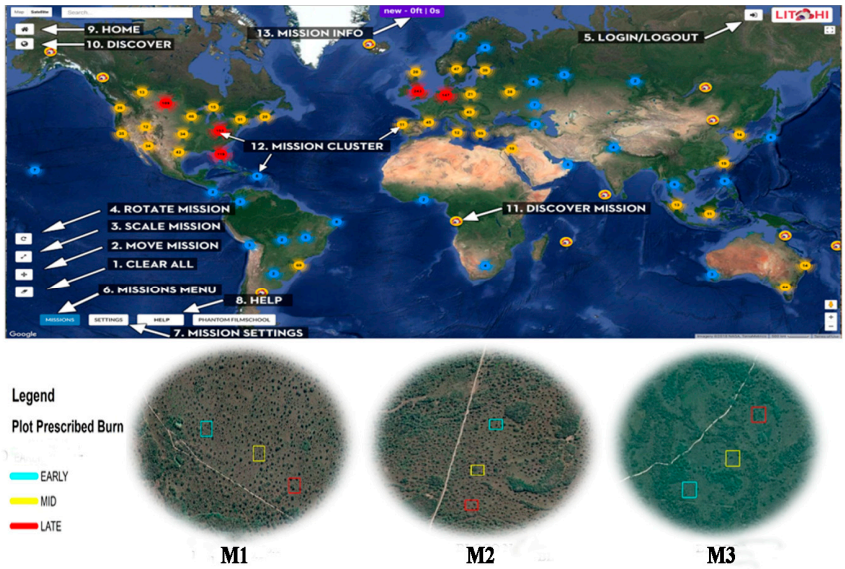


Figure S2. Flight planning

2. Checking the weather conditions and calibrating the drone

Before the flights began, the weather conditions associated with the presence of rain, wind speed, and cloudiness were checked. Likewise, the compass of the DJI Matrice 100 Multirotor Drone and the MicaSense Altum multispectral camera integrated sensor with reflectance panel were calibrated and the connection of the drone, sensor, and control was checked. According to [109], radiometric calibration of the camera with the panel should be performed to establish the relationship between the amounts of radiation emitted by the objects present on the ground surface to be evaluated and the amounts of radiation reflected by the orbital sensor. (**Figure S3**).

Figure S3. Drone calibration

3. Recognition of vegetation cover

A reconnaissance of the areas of vegetation physiognomy presents in the plots where the burning and drone flights were carried out, recognizing the tree, shrubland, grassland strata (**Figure S4**).

Figure S4. Recognition of plant physiognomies

4. Drone flight execution (Pre-fire)

After calibrating the drone, the flights of the macrohabitat were performed in the pre-burning phase to evaluate their state before the fire, where hundreds of photographs of the area of each pre-fire mission were obtained and processed in the Agisoft Metashape software. (**Figure S5**).

Figure S5. Pre-burn flight

5. Prescribed Burning

After the pre-fire phase flights, PBs were conducted on the late-season plots with the support of the support team and firefighters (**Figure S6** and **Figure S7**).

Figure S6. Prescribed Burn

- PB Macrohabitat 1

- PB Macrohabitat 2

- PB Macrohabitat 3

Figure S7. PBs in the experimental macrohabitats

6. Burn control

To avoid possible nuisance, after PB, fire sources were extinguished as a control measure (**Figure S8**).

Figure S8. Fire control

7. Execution of drone flight (post-fire)

After performing the PBS, post-fire flights were performed in the three experimental macrohabitats, where hundreds of photographs of the area of each post-burn mission were obtained and processed in Agisoft Metashape software (**Figure S9**).

Figure S9. Post-fire flight

8. Burn verification

Finally, photographic records were taken and the areas of the plots were verified after burning was performed (**Figure S10**).

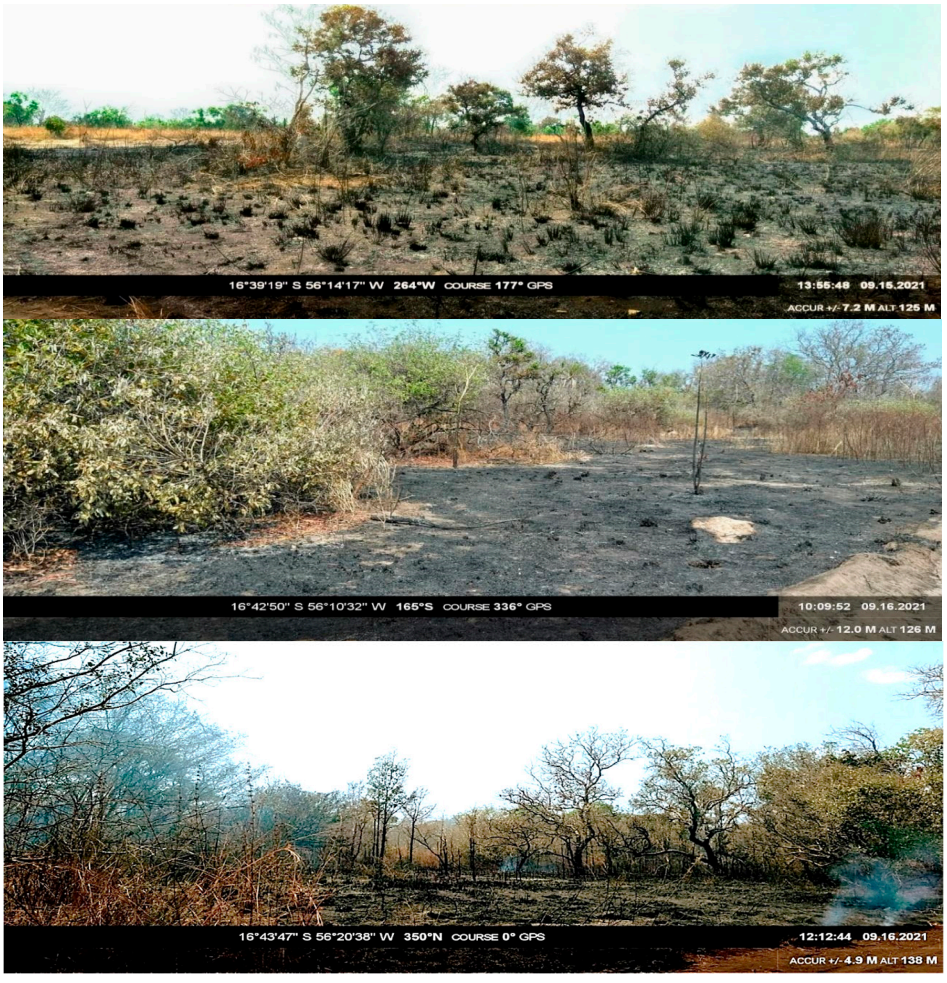
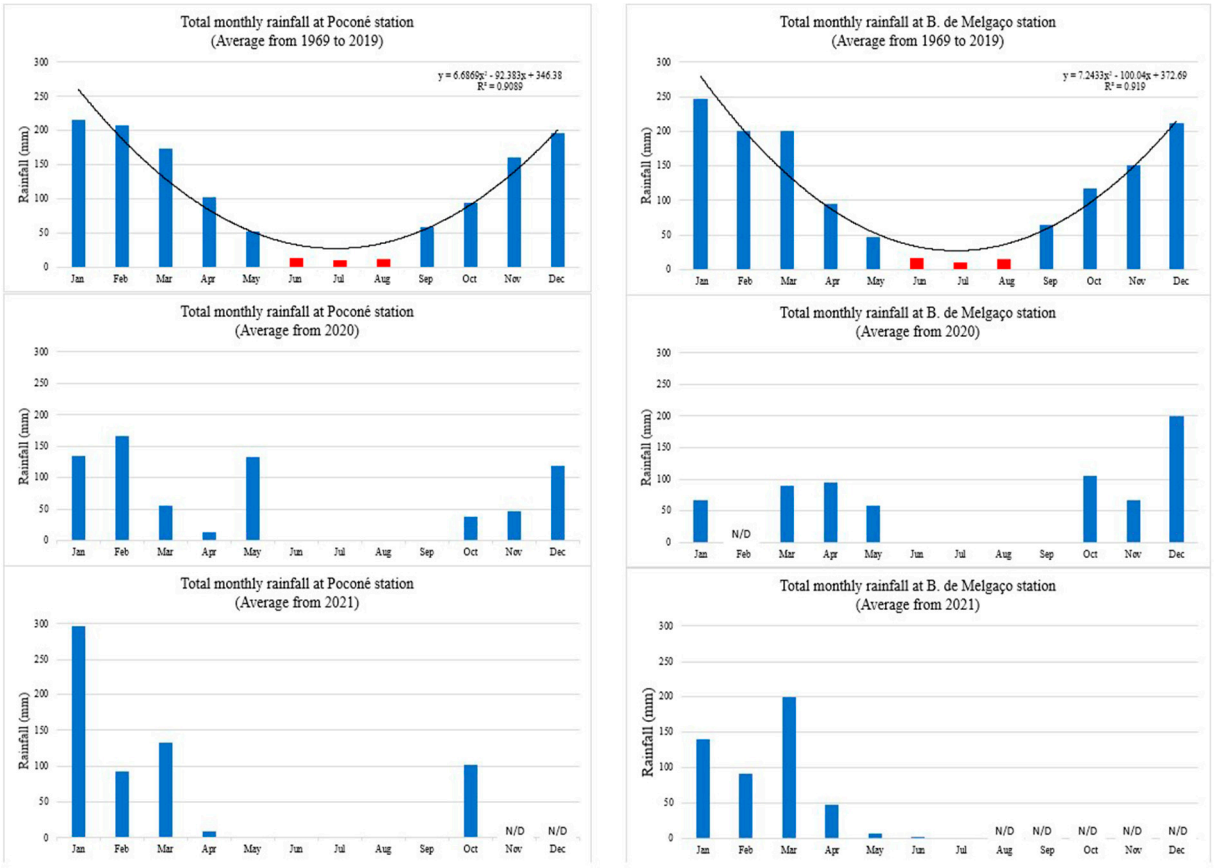


Figure S10. Burn verification

Table S1. Percentage PBs severity

PBs	Early PBs			Mid PBs			Late PBs		
Macrohabitat	**M1**	**M2**	**M3**	**M1**	**M2**	**M3**	**M1**	**M2**	**M3**
Unburned									
Tree cover	3.51	0.41	15.13	6.18	2.26	5.84	8.65	7.75	40.94
Shrubland	3.10	0.06	17.54	4.08	3.64	2.71	2.71	3.19	32.62
Grassland	6.84	0.09	32.68	6.72	11.40	2.16	3.35	3.45	15.47
Low Severity									
Tree cover	4.49	8.65	5.33	1.73	2.77	4.56	5.43	6.12	2.63
Shrubland	4.73	0.44	4.13	3.23	5.92	10.36	2.55	2.62	0.81
Grassland	14.75	4.17	13.37	17.40	14.15	11.77	18.14	17.21	3.21
Medium Severity									
Tree cover	2.17	3.15	1.29	0.55	2.41	2.24	0.53	0.53	0.55
Shrubland	2.74	0.73	1.02	1.95	4.39	5.54	0.21	0.34	0.38
Grassland	19.79	51.51	7.54	18.29	13.98	16.64	19.90	17.92	1.91
High Severity									
Tree cover	0.83	0.88	0.13	0.25	1.14	1.36	0.12	0.10	0.15
Shrubland	1.44	0.51	0.12	1.28	3.51	4.29	0.07	0.20	0.18
Grassland	19.34	21.17	2.02	18.65	16.14	16.59	19.30	21.44	1.06
Very High Severity									
Tree cover	0.46	0.22	0.02	0.13	0.32	0.61	0.04	0.02	0.03
Shrubland	0.87	0.18	0.02	0.84	1.22	2.52	0.01	0.07	0.06
Grassland	15.64	8.60	0.44	19.40	17.45	13.43	19.45	19.85	0.56



Code	Pluviometry Station	Municipality	State	Latitude (Decimal degrees)	Longitude (Decimal degrees)	Altitude (m)
1665002	Poconé	Poconé	MT	-16.32	-56.55	126
1655002	B. de Melgaço	Barão de Melgaço	MT	-16.19	-55.97	125

MT: Mato Groso, N/D: No Data.
Data source: Historical series of National Water Agency Brazil (ANA).
https://www.snirh.gov.br/hidroweb/serieshistoricas

Figure S11. Pattern of precipitation regime in the region