Should we move on from the CIELAB colour space?

Rebecca O'Leary

(Field Statistician)

Curtin University, Perth, Western Australia

Presented to Australasian Applied Statistics Conference 2024

Curtin University

ARTCARE

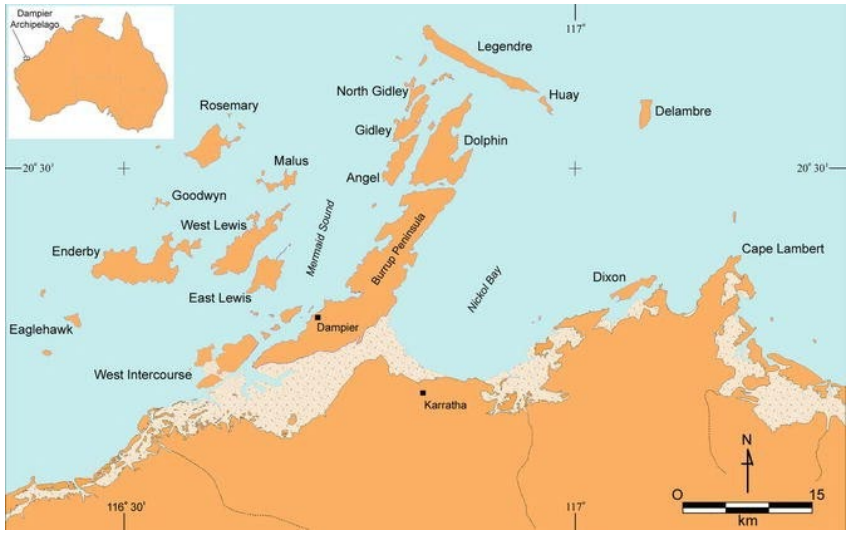
Department of Water and Environmental Regulation

GOVERNMENT OF WESTERN AUSTRALIA

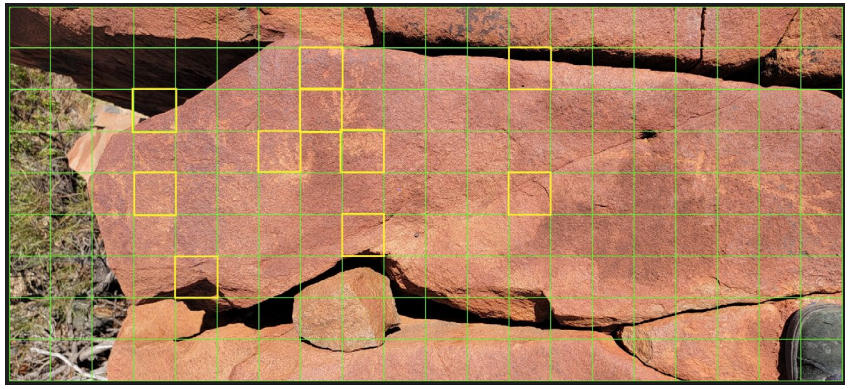
MURUJUGA Aboriginal Corporation

Stories from the Stones

Murujuga Rock Art Monitoring Program

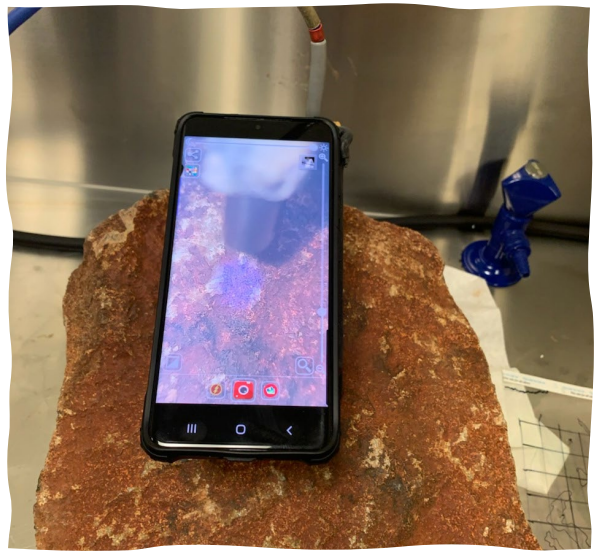


- Investigate impact of industrial air emissions on rock art near Karratha
- 1 component: monitor long-term trends in colour of rock art panels
- 54 rock art panels across 5 rock types
- Grid place on panel &10 random target selected
- 7 fieldwork campaigns between 2022 & 2024



Measure colour change in the rocks

- Spectrometer instrument
  - coaxial fibre optic cable
  - transmitting xenon light to surface
  - transmitting spectral data back to instrument
- Box & black cloth to eliminate ambient light from measurements
- Colour measurement 1-2 mm spot size
- Collect spectral data in wavelength range 195 to 807 nm



How to take a measurement

- Calibration:
  - Reference – lamp on
  - Dark current – lamp off
- Rock art colour
  - Place box with probe attached
  - Sequence of images to re-locate target, final macro images of the probe and light source.
  - Measure colour on the rock by taking at least 10 reps

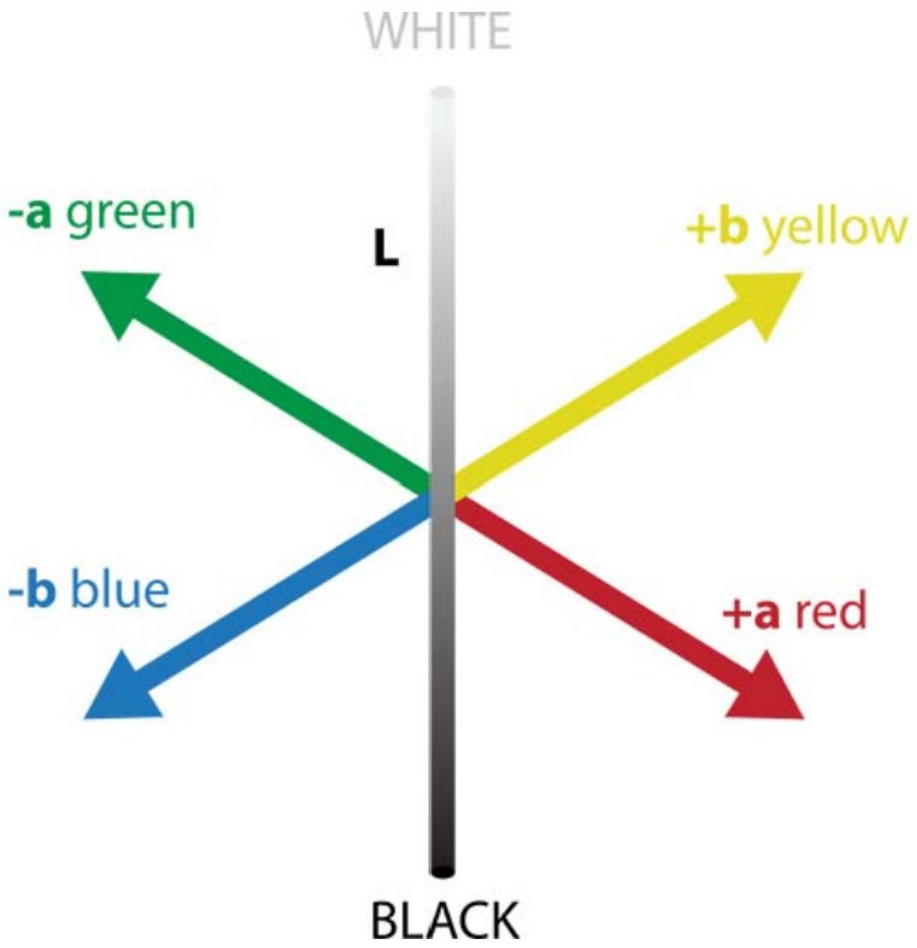
Colour data

- W represents the wavelength of light in nanometres (nm)
- D is the dark field photon count
- R is the reference (illumination) photon count
- S is the sample sensed photon count
- P is the processed (calculated %) reflectivity for each wavelength:

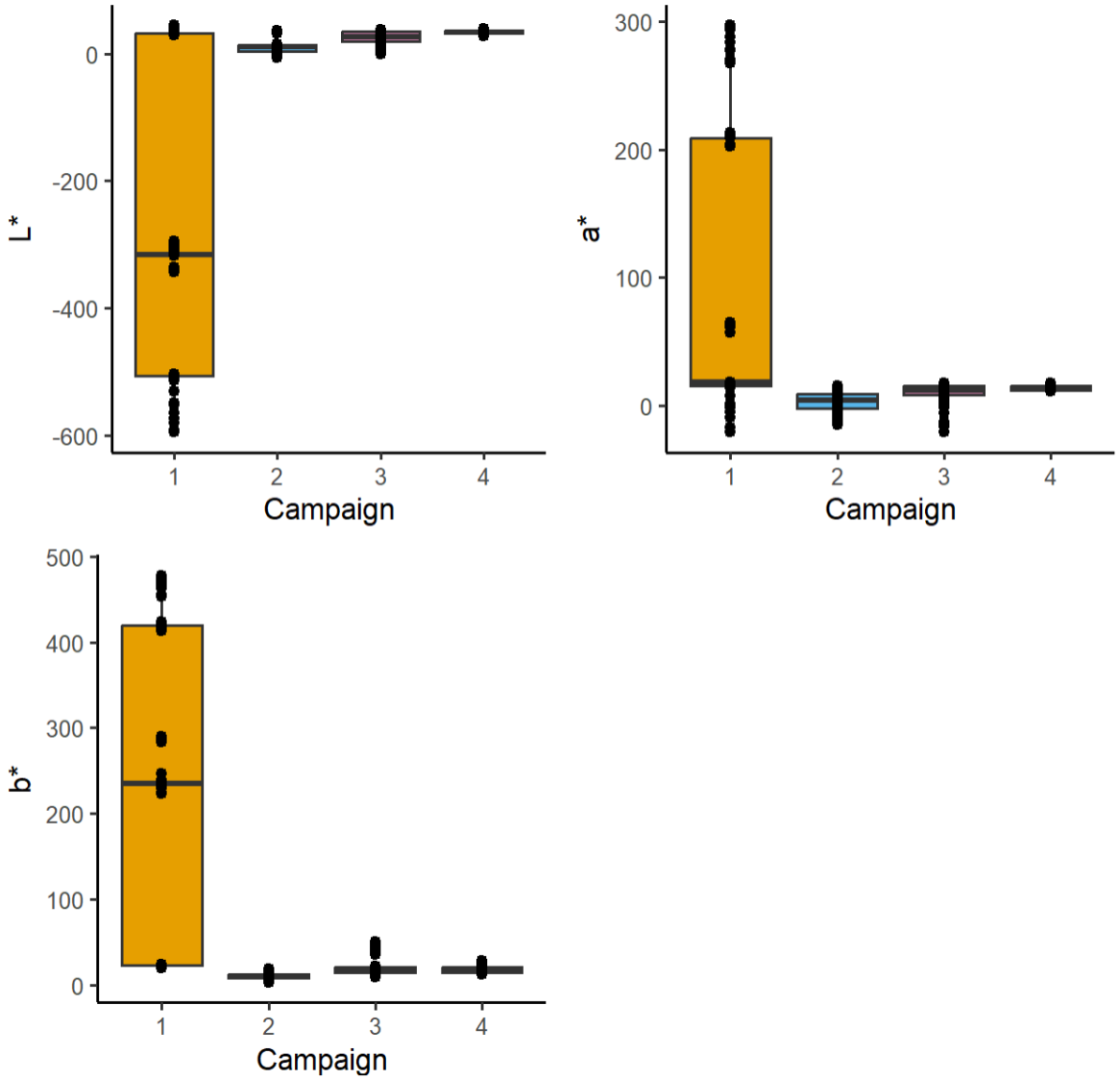
$$P = \frac{S - D}{R - D} \times 100$$

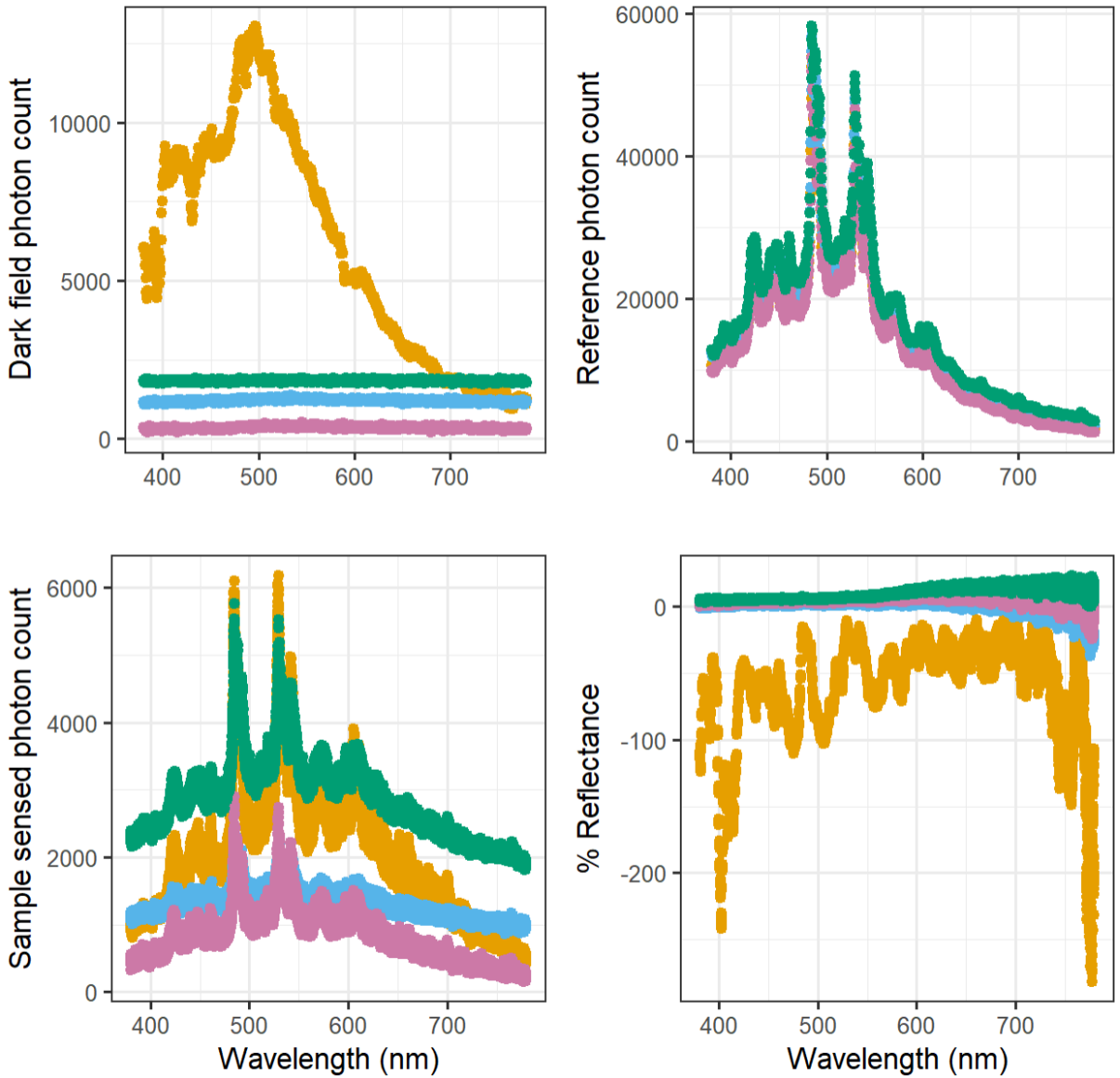
CIELAB

- Previous research converted data into CIELAB colour space index
- CIELAB = perceptual colour in 3 coordinates (L*, a*, b*) defined by CIE international standards
- Colour spectrum data for wavelengths 380 to 780 nm (n = 950) converted into 3 numbers (L*, a*, b*).
- Traditionally, Euclidean distance (ΔE) between L*, a*, b* coordinates used to detect perceptual colour differences, with ΔE > 2 indicating a difference.
- Extreme weather near Karratha (& other factors) have caused instrument faults
- Can these faults be observed in CIELAB?

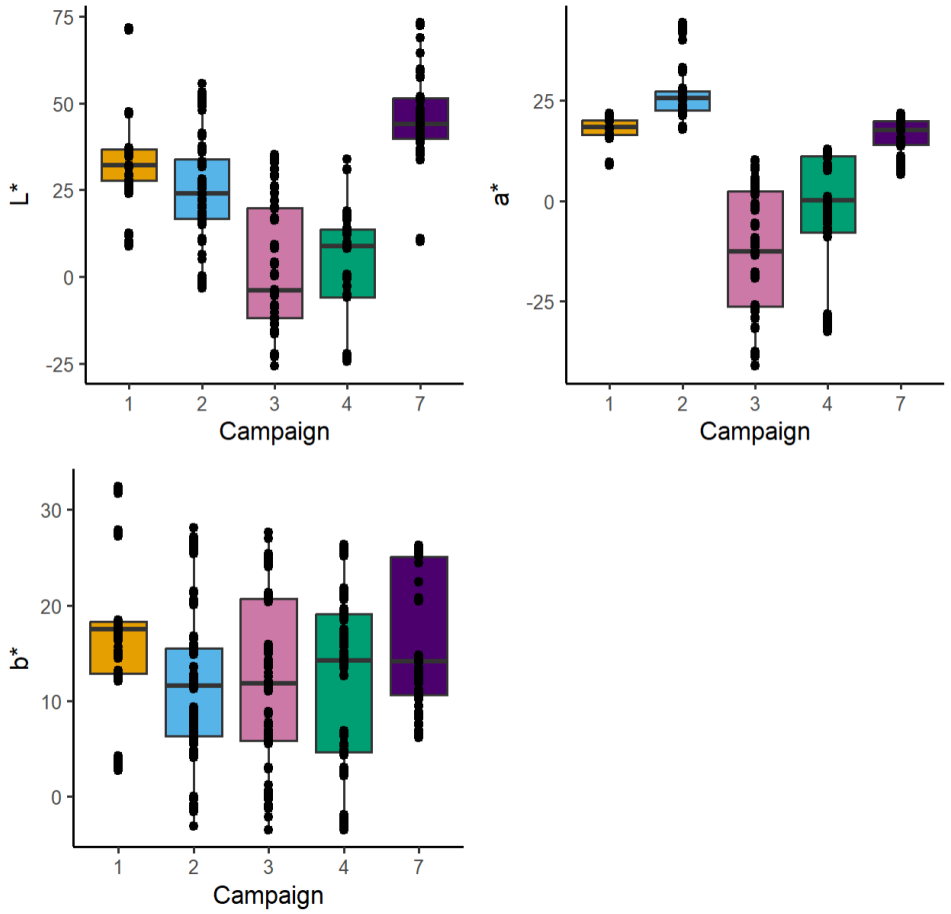


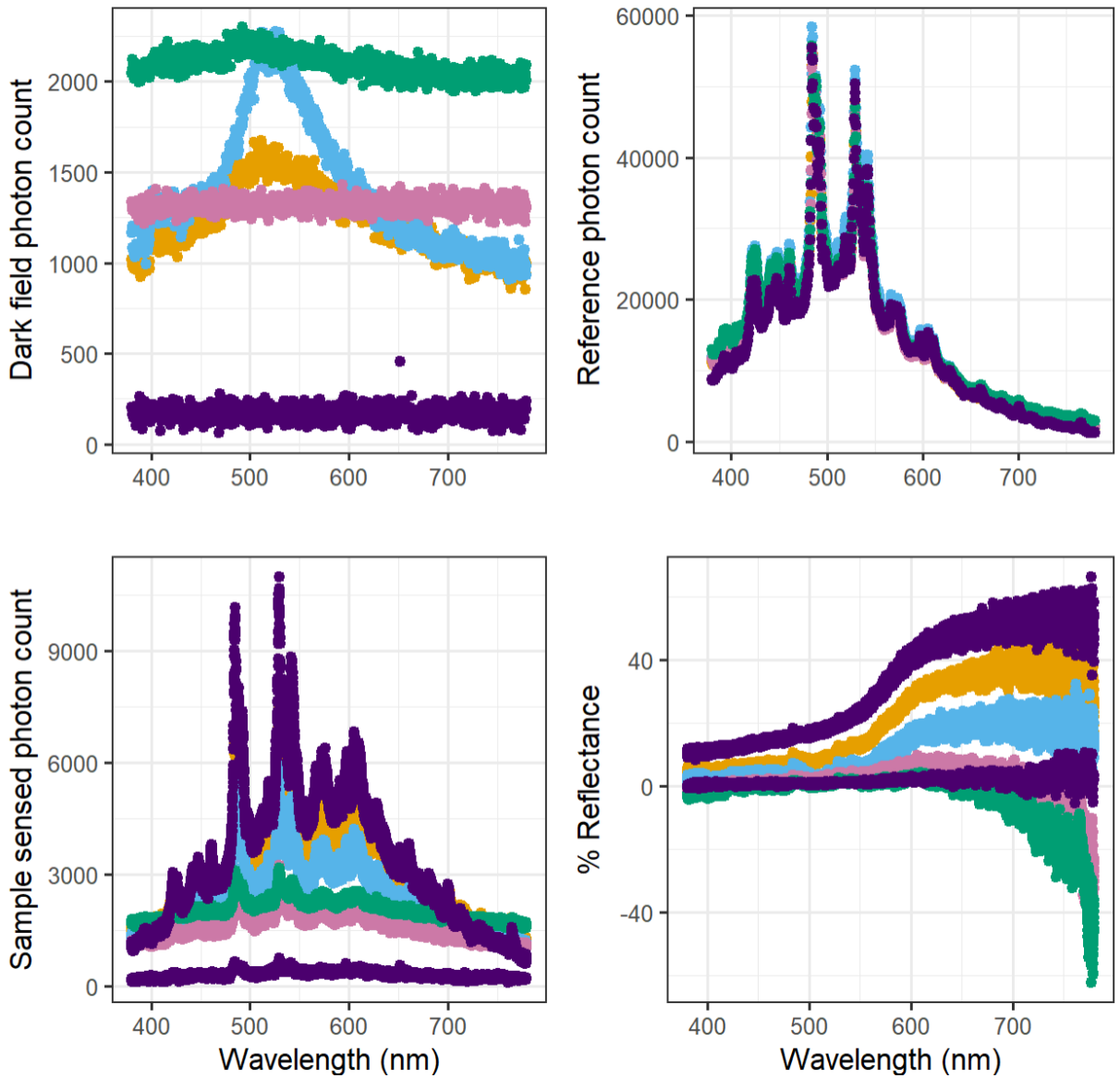
Example fault 1




Dark field photon count
10000
5000
0
400
500
600
700
Reference photon count
60000
40000
20000
0
400
500
600
700
Sample sensed photon count
6000
4000
2000
0
400
500
600
700
Wavelength (nm)
% Reflectance
0
-100
-200
400
500
600
700
Wavelength (nm)

Example fault 2




Dark field photon count
2000
1500
1000
500
0
400
500
600
700
Reference photon count
60000
40000
20000
0
400
500
600
700
Sample sensed photon count
9000
6000
3000
0
400
500
600
700
Wavelength (nm)
% Reflectance
40
0
-40
400
500
600
700
Wavelength (nm)

Field colour measurements using HDX

Initial setup | Field colour measurement | About

Calibration

Store reference

Store dark current

Colour measurments

Target:

- (•) 1
- ( ) 2
- ( ) 3
- ( ) 4
- ( ) 5
- ( ) 6
- ( ) 7
- ( ) 8
- ( ) 9
- ( ) 10

Turn on light | Turn off light

Record spectra

Processed reference: 1

Processed dark current: 1

Processed targets: 1

Reference recorded

Reference valid

Dark current recorded

Dark current valid

Target measurement recorded: 1

Target measurement valid: 1

Summary

- CIELAB
  - Sometimes reveals problems but the exact nature or root cause is unclear
  - Is there a temporal trend or problem with one or more campaigns?
- Plots of raw data: wavelength vs dark current, reference, sample & % reflectance reveal problems
- Problems include:
  - Lamp on/off
  - Stray light
  - Vertical rocks
- R shiny – checks data in field and can be used by the indigenous rangers

Acknowledgements

- I would like to express my gratitude to all those who have supported and contributed to this research. I particularly grateful to Glen Aubrey, Kasziem Bin-Sali and Andrew Thorn who collected this data.
- This work was supported by MAC (Murujuga Aboriginal Corporation), and DWER (Department of Water and Environmental Regulation).
- Also like to thank Ben Mullins and Statistical team


passive samplers
real time monitors
bucket samplers
snazzy instruments
PATINA
Ramboll