

# Leaf Mass per Area of wetland vegetation under water stress

Analyzed with imaging spectroscopy

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Salvador Sánchez-Carrillo  
Santos Cirujano

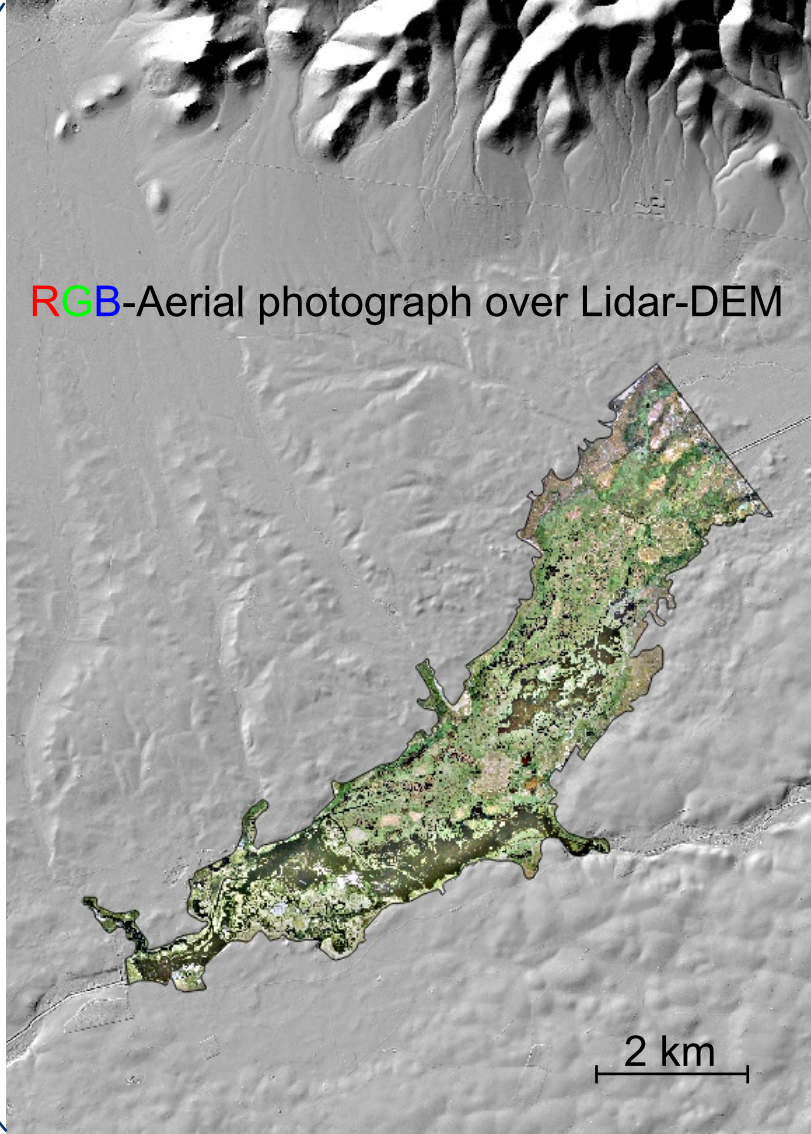


Alvarez Cobelas & Cirujano (1996)

# Tablas de Daimiel



RGB-Aerial photograph over Lidar-DEM

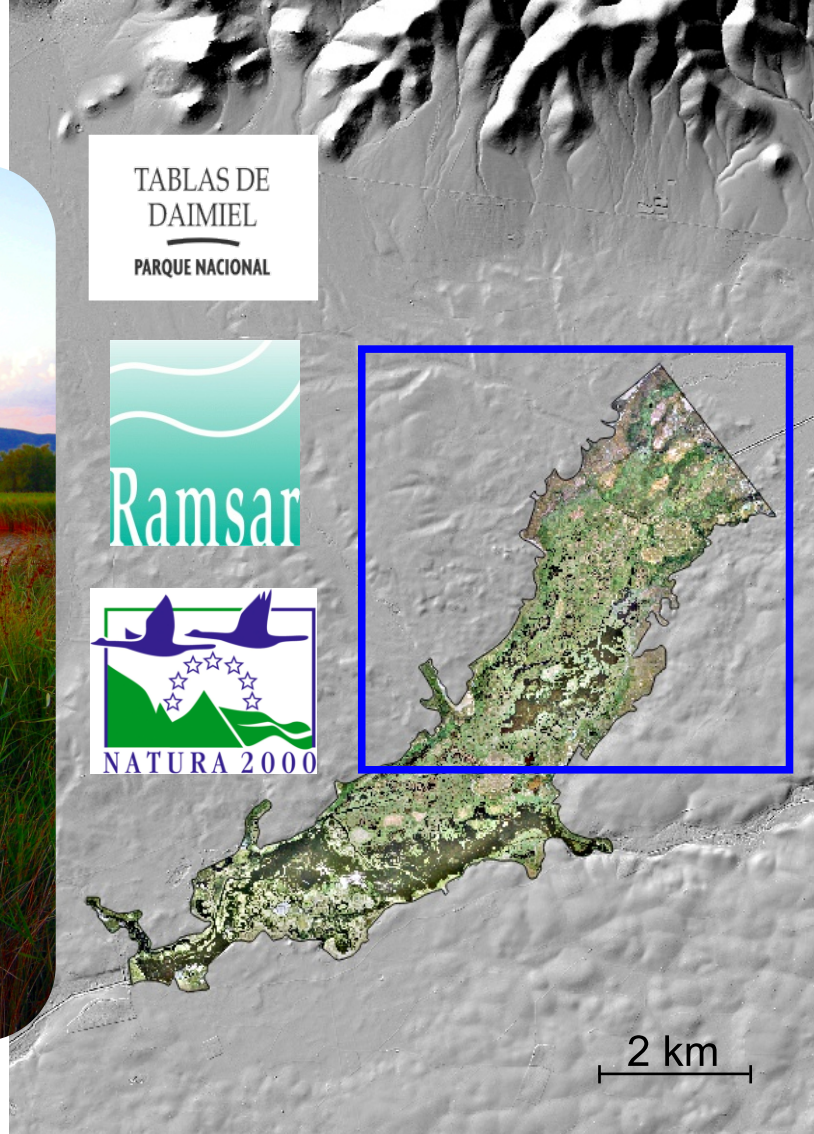




# Tablas de Daimiel



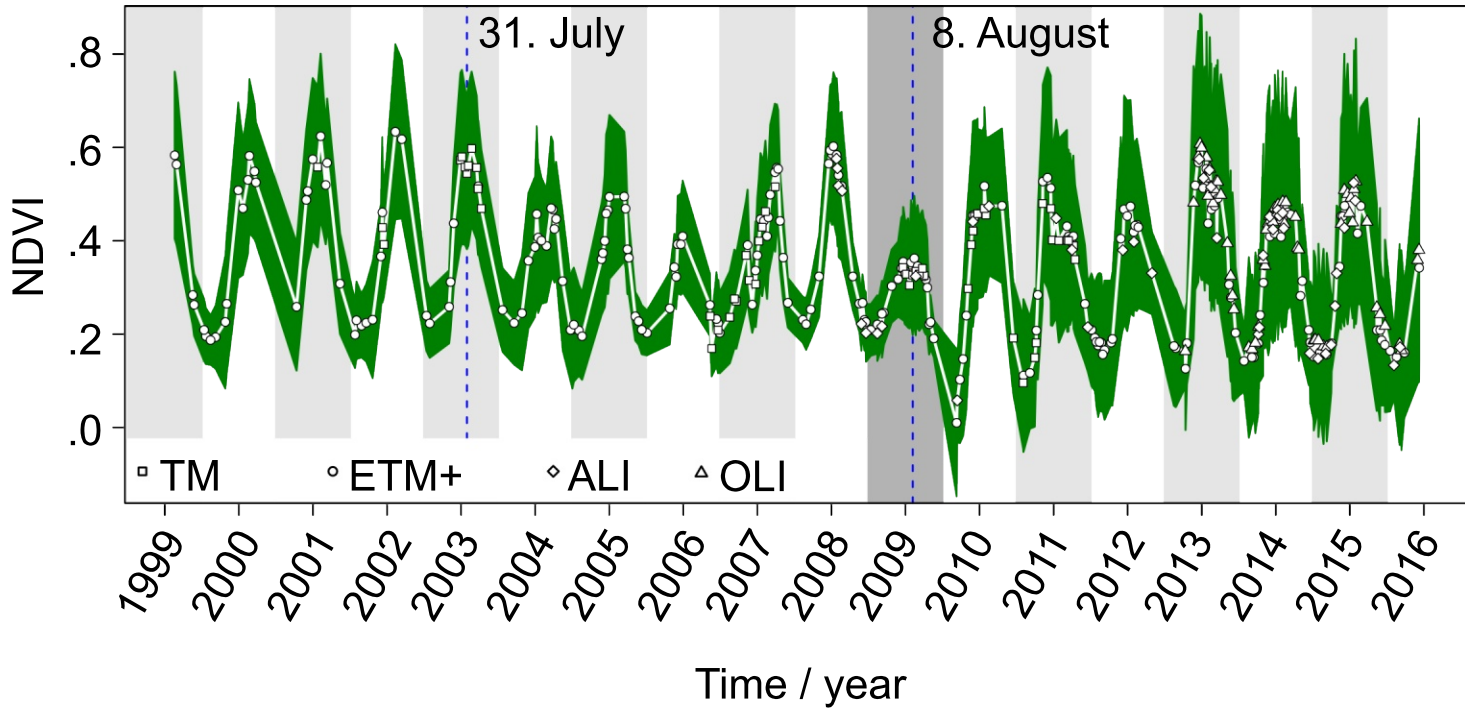
1 Feilhauer et al. (2018) Ecol Ind



# Recent vegetation dynamics

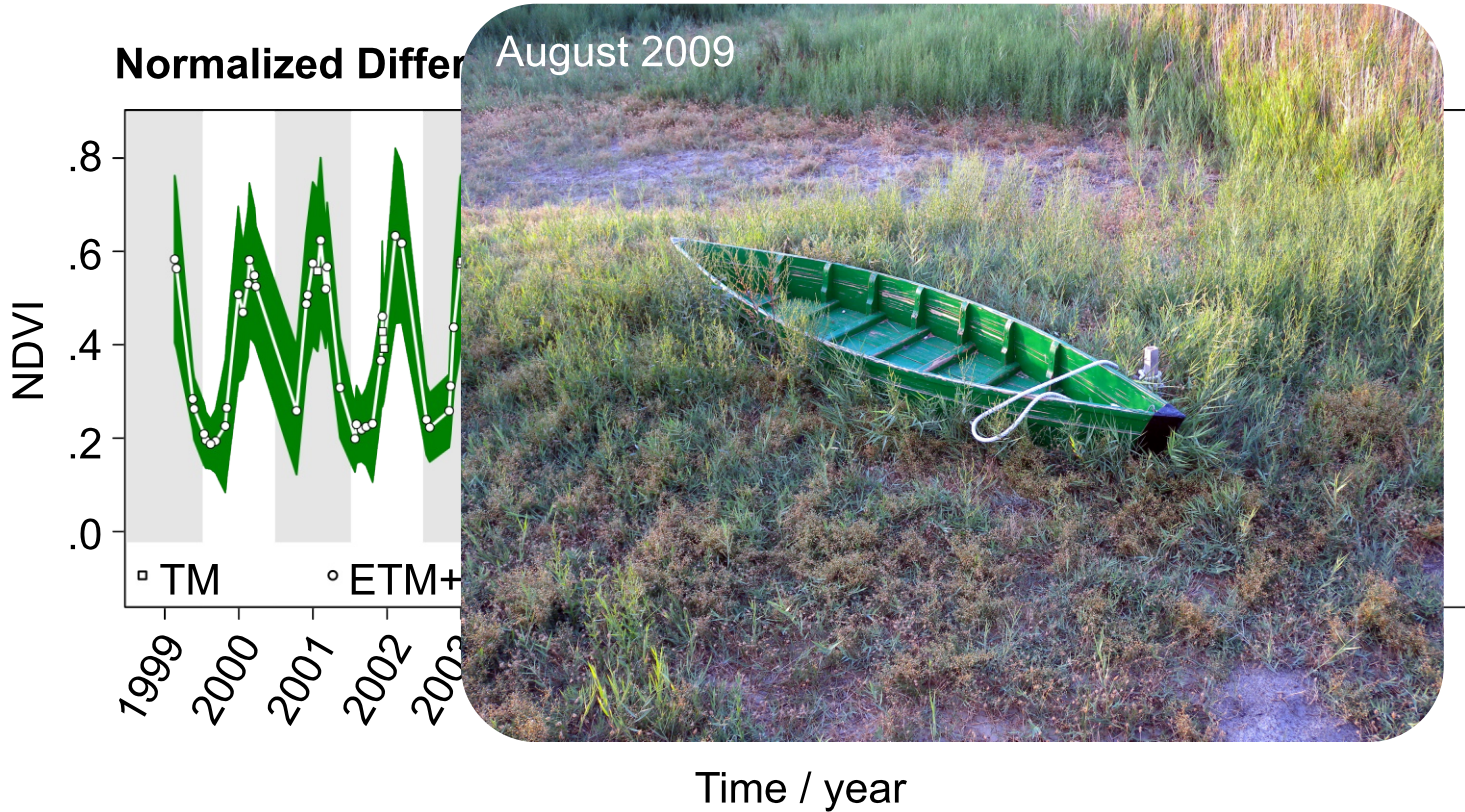
$$NDVI = \frac{NIR - Red}{NIR + Red}$$

## Normalized Difference Vegetation Index (NDVI)



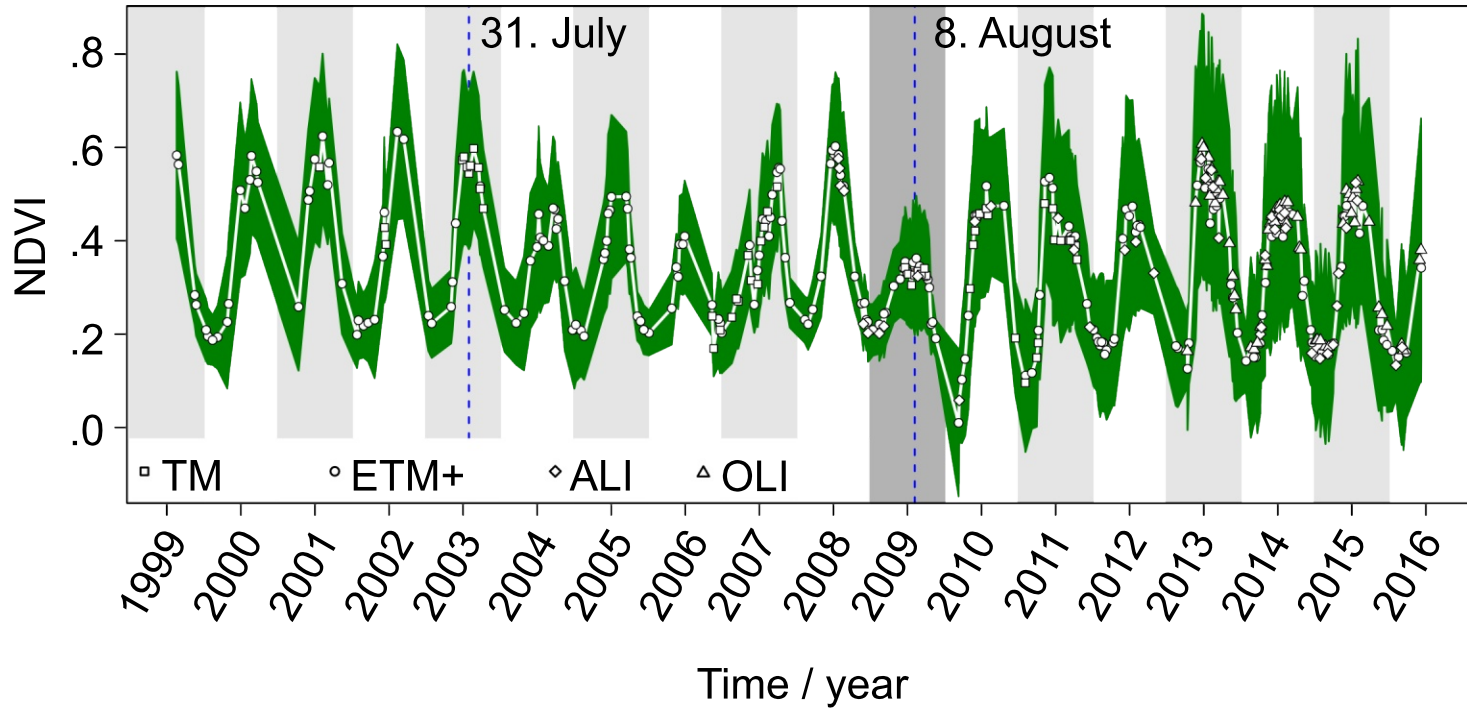


# Recent vegetation dynamics

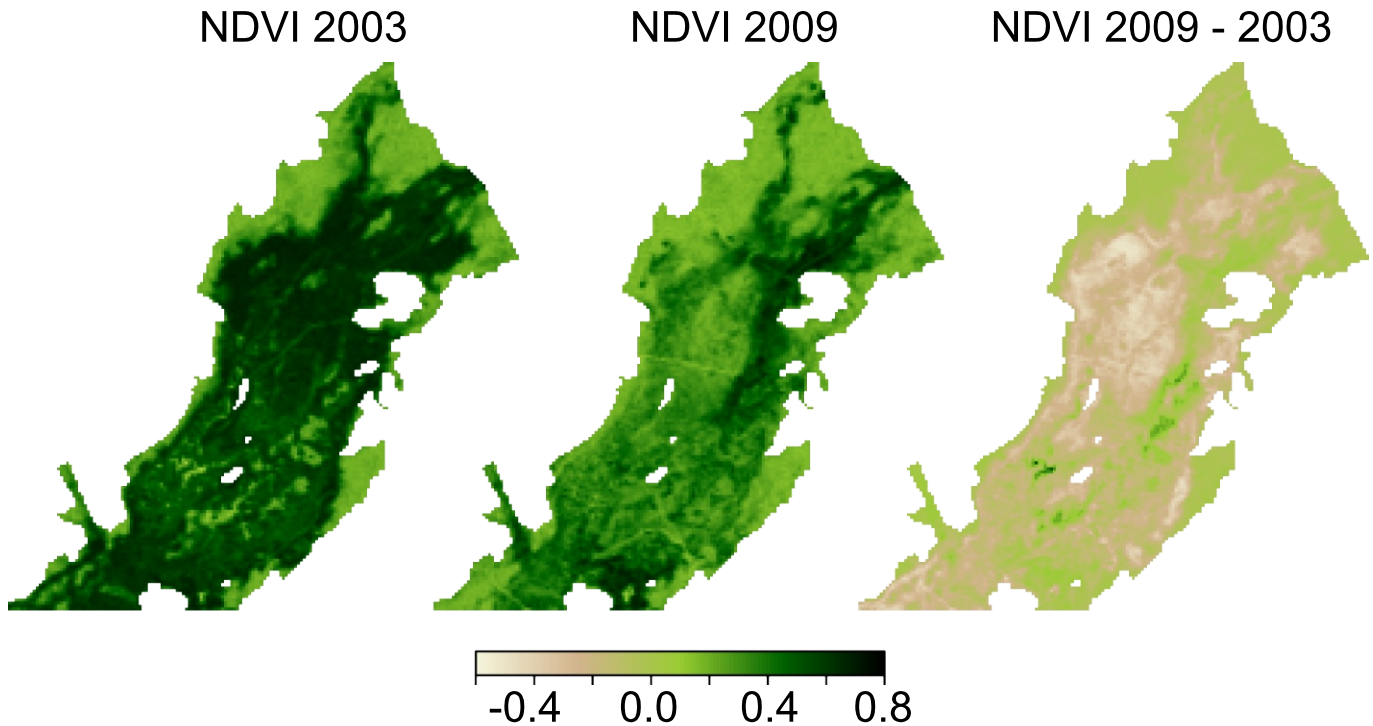


# Recent vegetation dynamics

## Normalized Difference Vegetation Index (NDVI)



# Recent vegetation dynamics





# Leaf Mass per Area

$$LMA = \frac{\text{Leaf dry mass}}{\text{Leaf area}}$$



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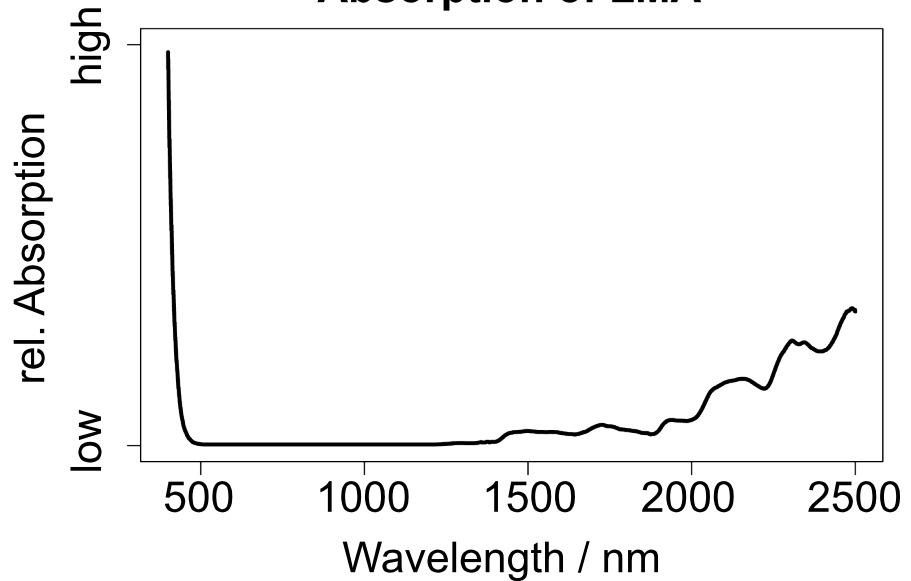
**Can we map effects of long-term vegetation stress on Leaf Mass per Area with remote sensing?**



# Leaf Mass per Area

$$LMA = \frac{\text{Leaf dry mass}}{\text{Leaf area}}$$

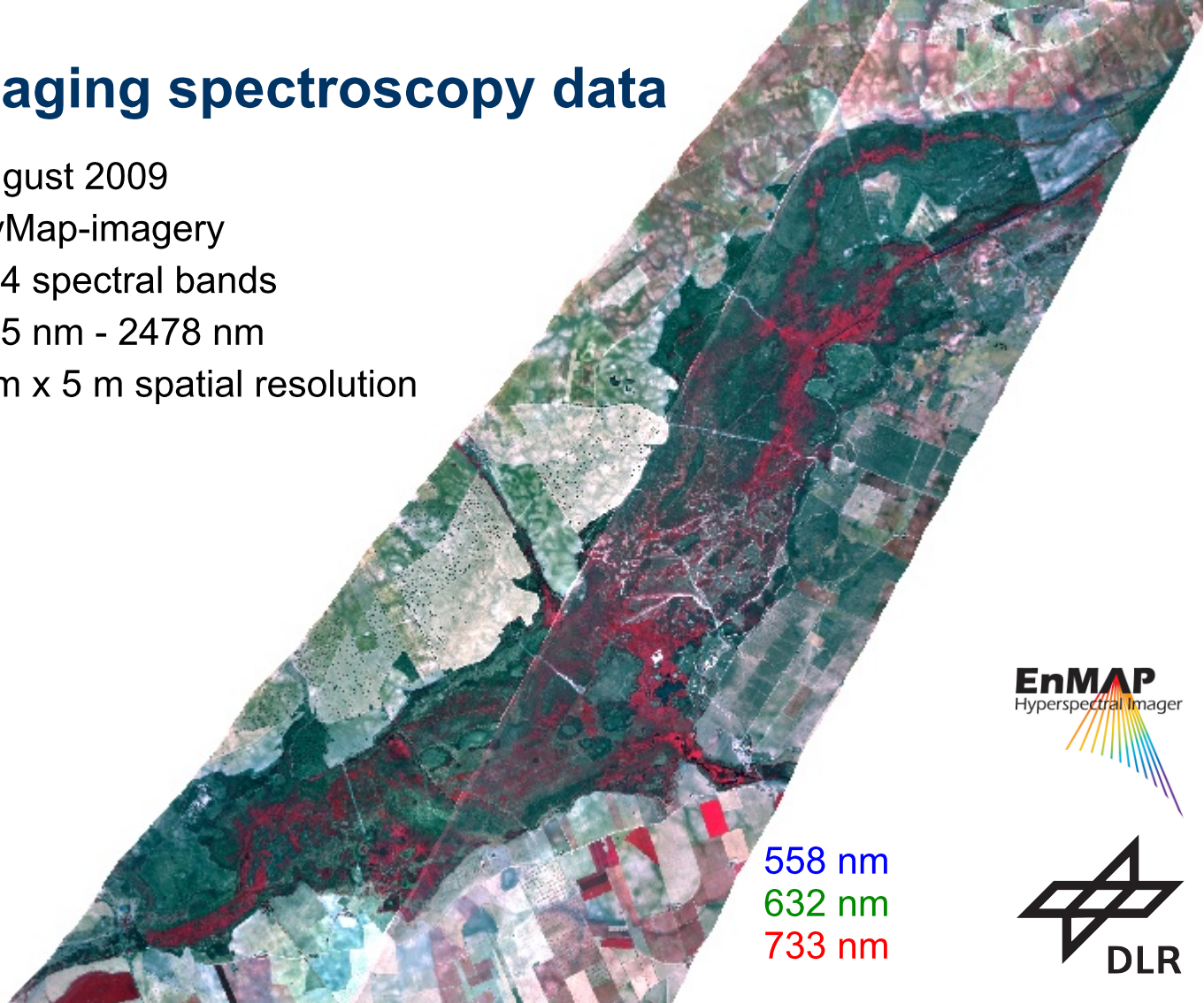
Absorption of LMA





# Imaging spectroscopy data

- August 2009
- HyMap-imagery
- 124 spectral bands
- 455 nm - 2478 nm
- 5 m x 5 m spatial resolution



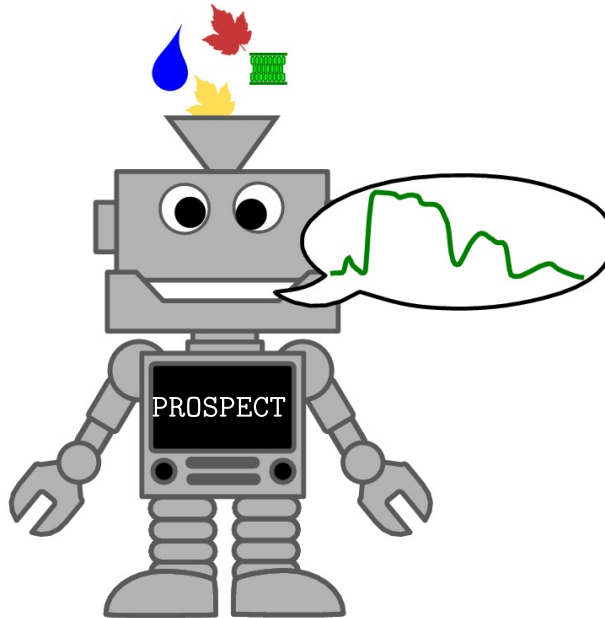
**EnMAP**  
Hyperspectral imager



558 nm  
632 nm  
733 nm



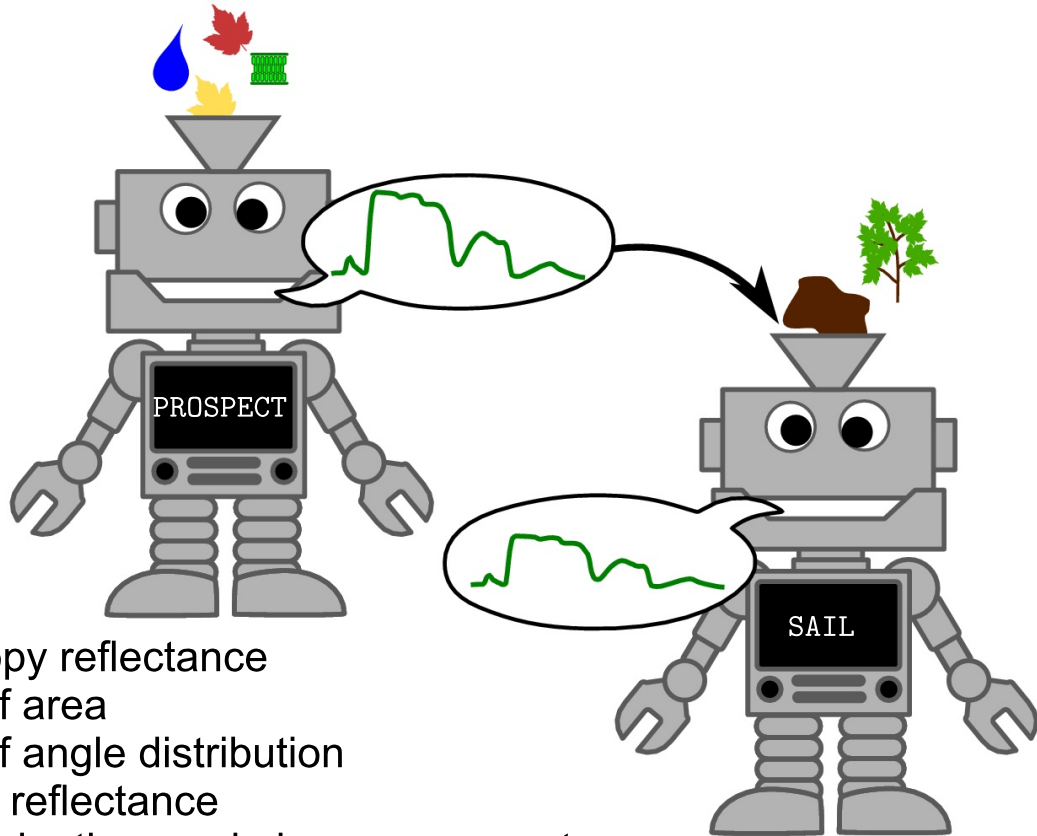
# Analysis



Leaf-level reflectance

- Pigments
- Water content
- Leaf Mass per Area
- Mesophyll structure

# Analysis

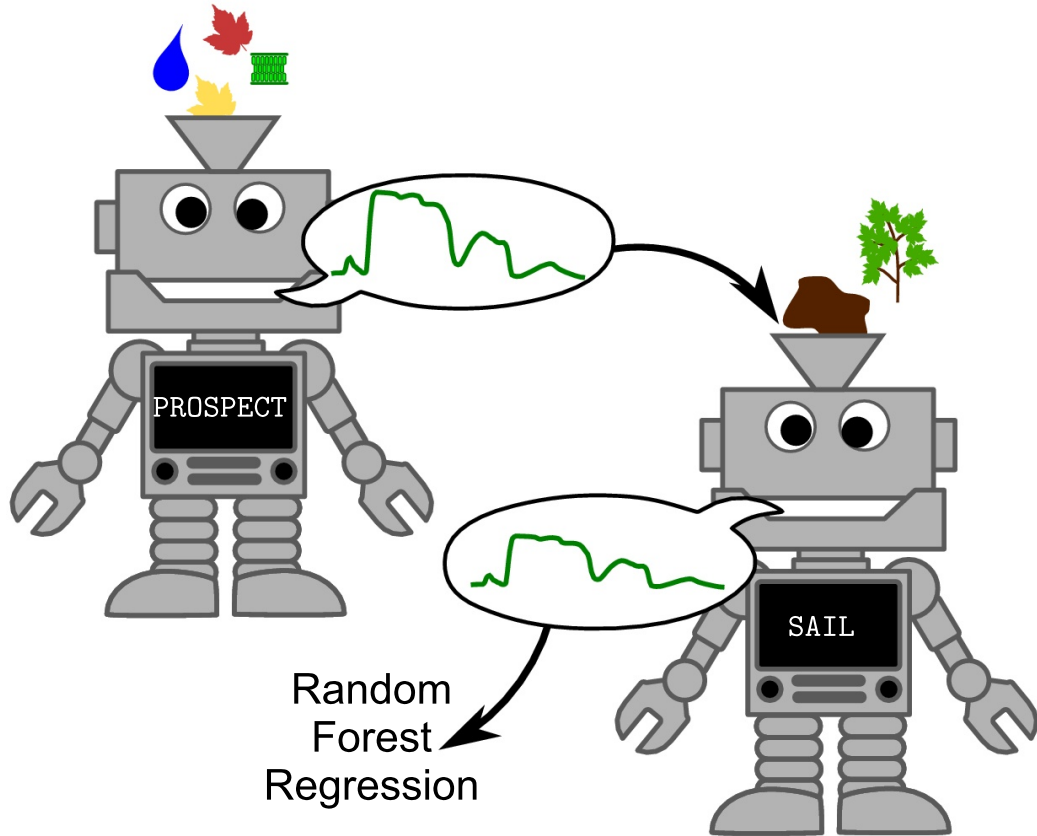


Canopy reflectance

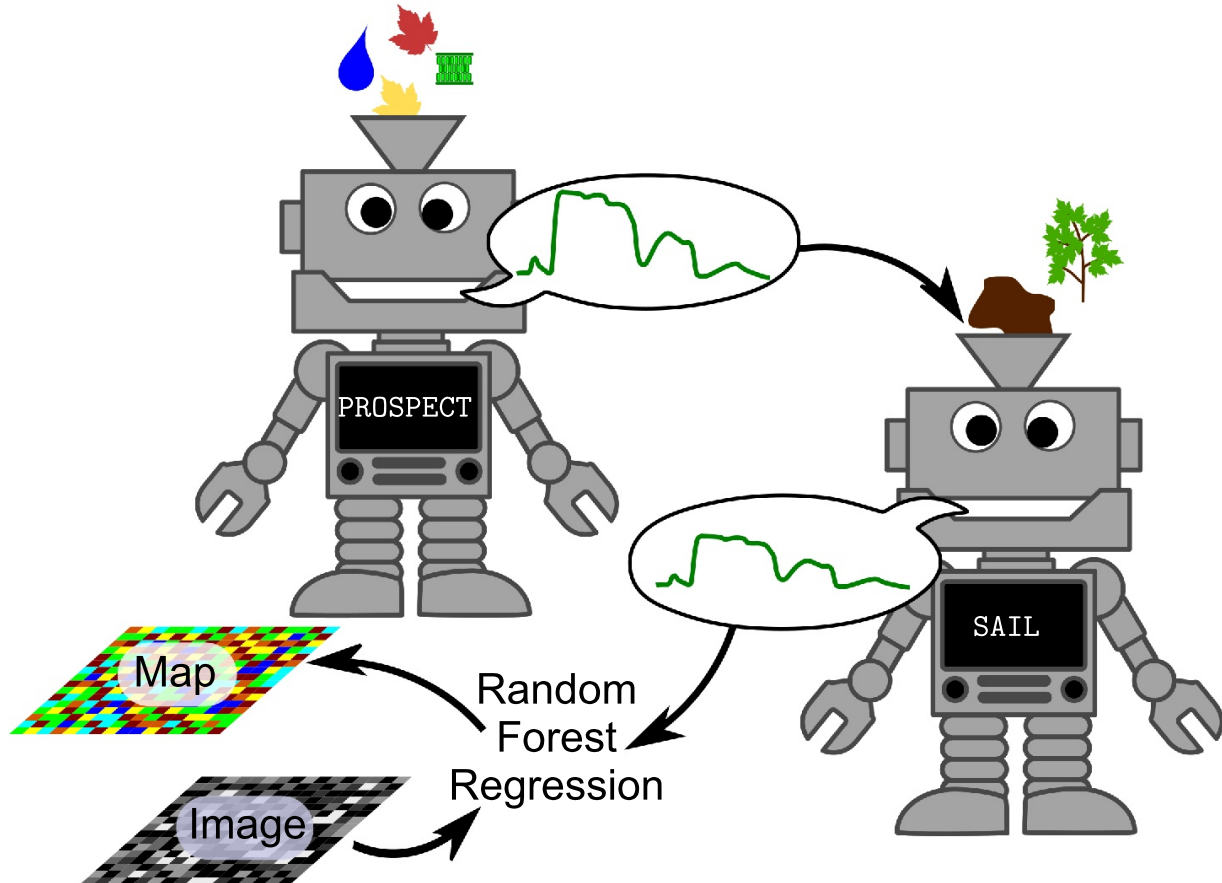
- Leaf area
- Leaf angle distribution
- Soil reflectance
- Illumination- and observer geometry



# Analysis

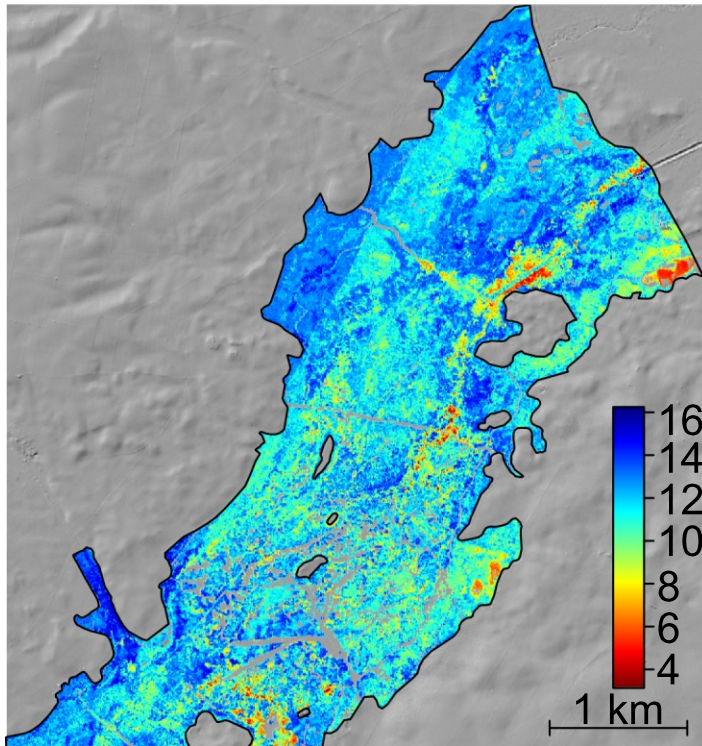


# Analysis



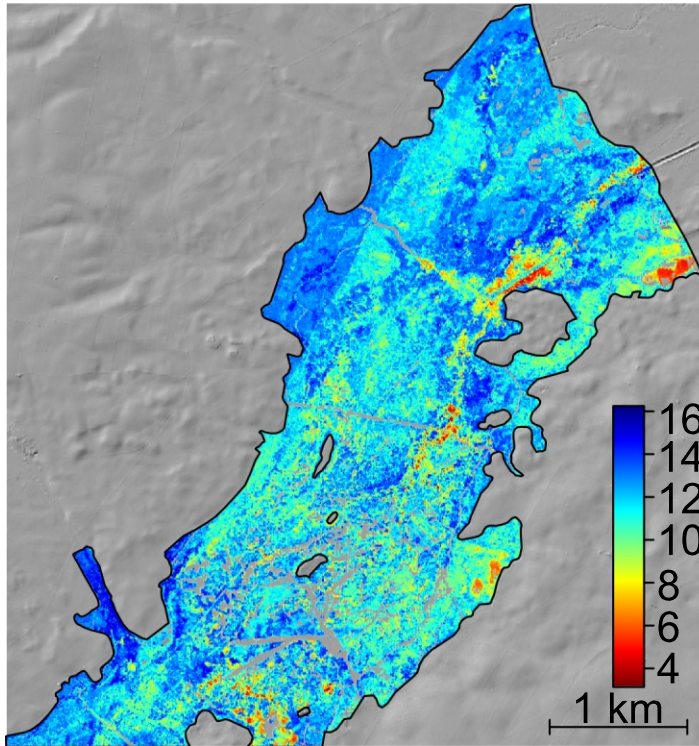
# Spatial patterns of LMA

LMA / mg cm<sup>-2</sup>

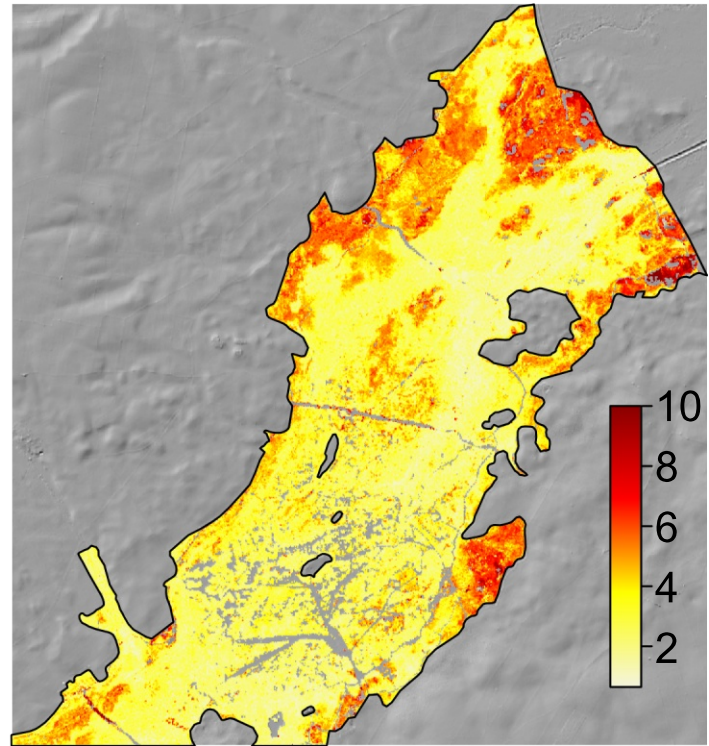


# Spatial patterns of LMA

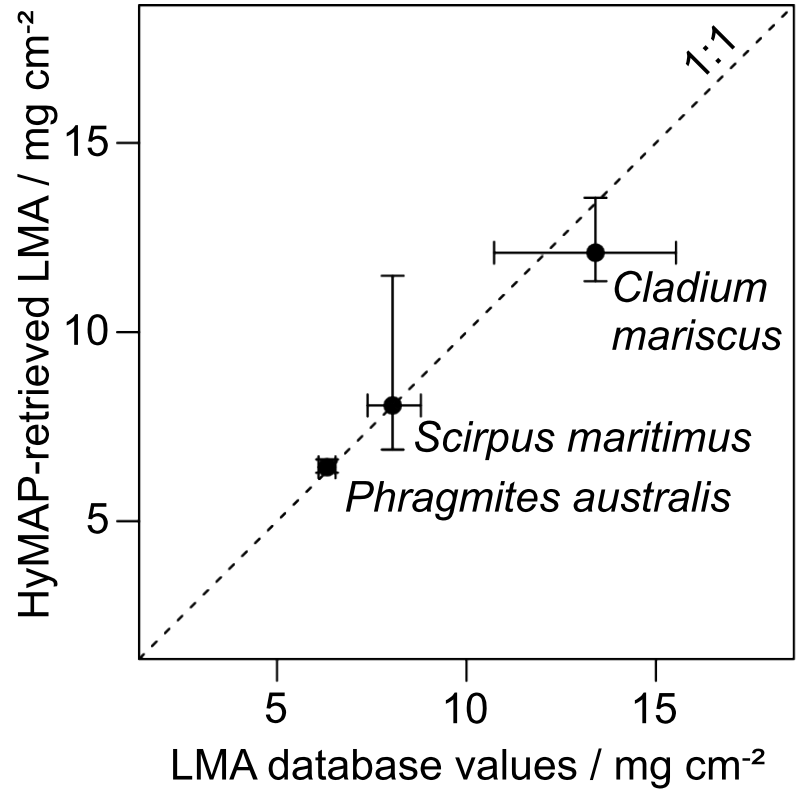
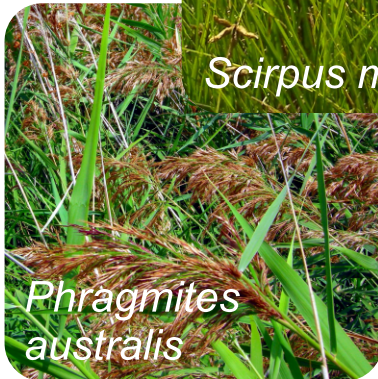
LMA /  $\text{mg cm}^{-2}$



Spectral residuals (RMSE) / %

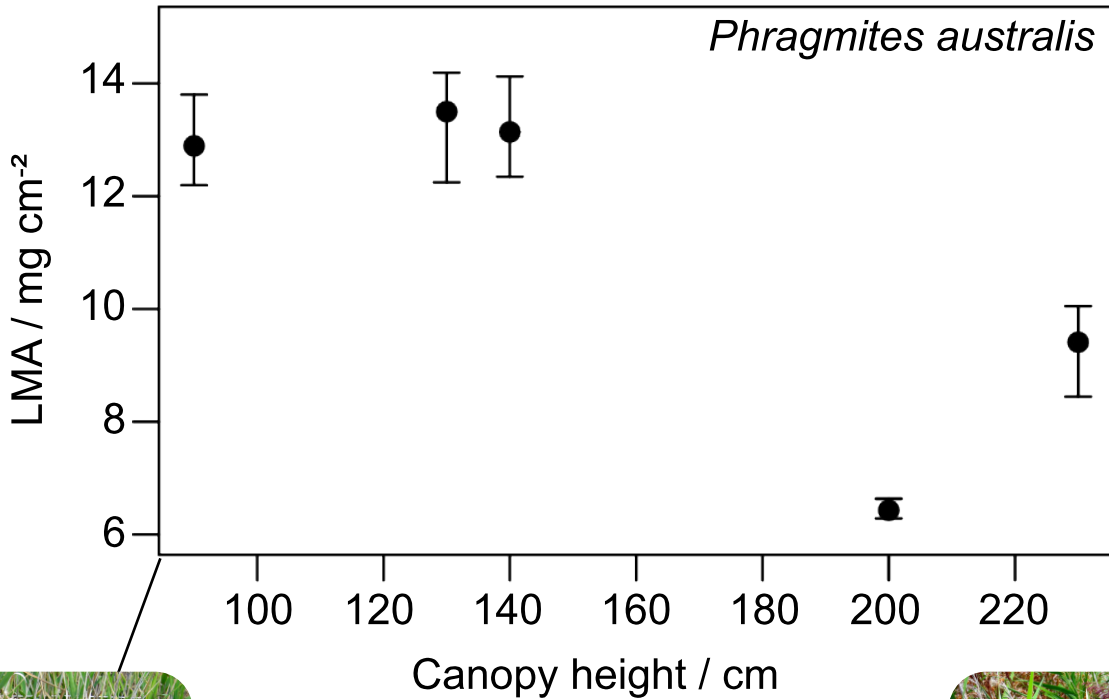


# Inter-specific differences

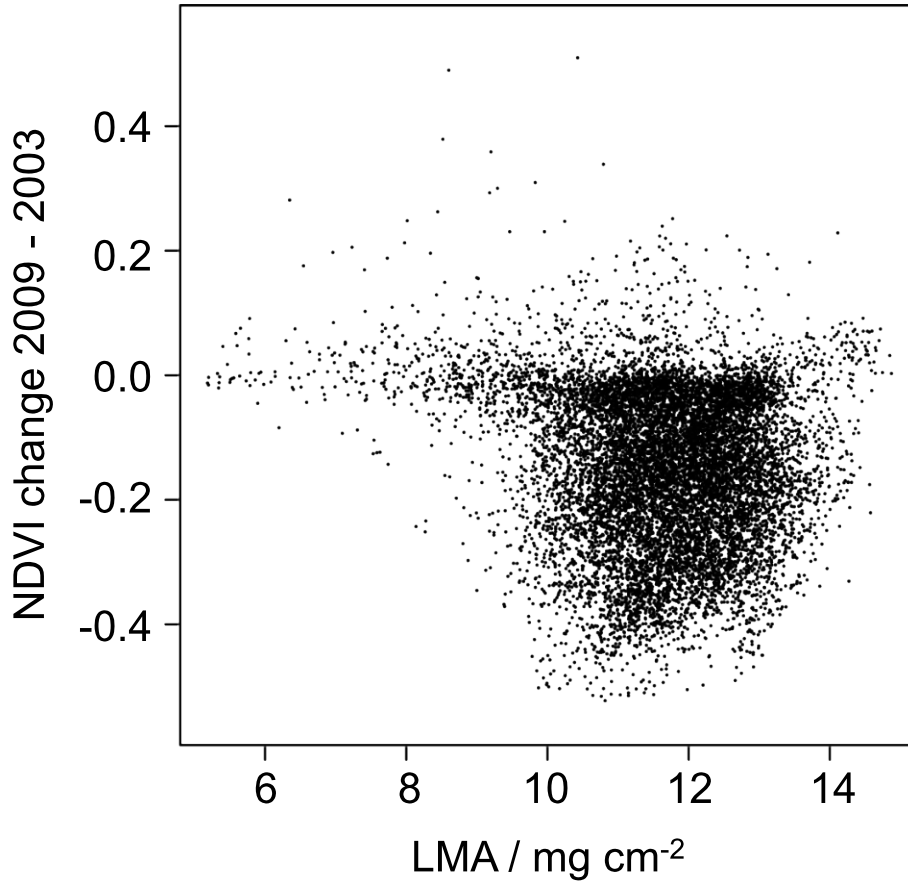




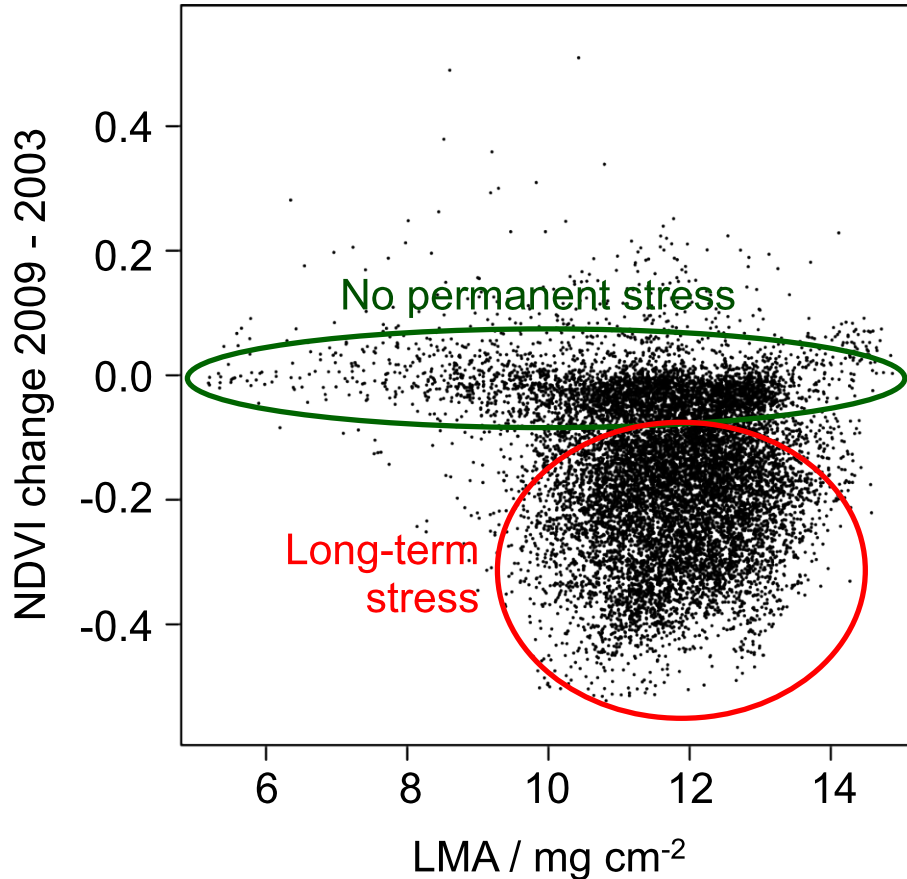
# Inter-specific plasticity



# Effects of long-term stress



# Effects of long-term stress



# What's new?

😊 Application of physical radiative transfer models to address ecological questions

😊 Spectral analysis of leaf trait plasticity



# Thanks to...

Angela

Anna

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Martin

Raquel

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Sebastian

the other Sebastian

Victoria

and the national park rangers

and administration

# DFG



## DLR



Bundesministerium  
für Wirtschaft  
und Technologie

