VEGETATION FUNCTIONAL AMPLITUDES ALONG THE ELEVATION AND RAINFALL GRADIENTS IN INDIAN ECOSYSTEMS USING AVIRIS-NG

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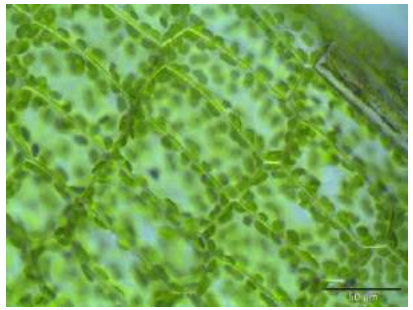
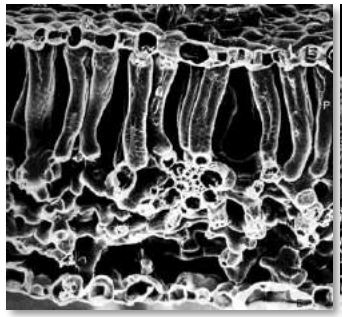
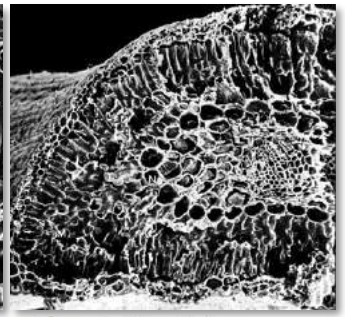
FOLIAR FUNCTIONAL TRAITS:
GENERAL CONCEPTS

Foliar Functional Traits







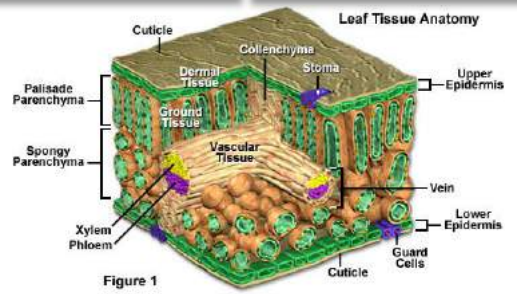
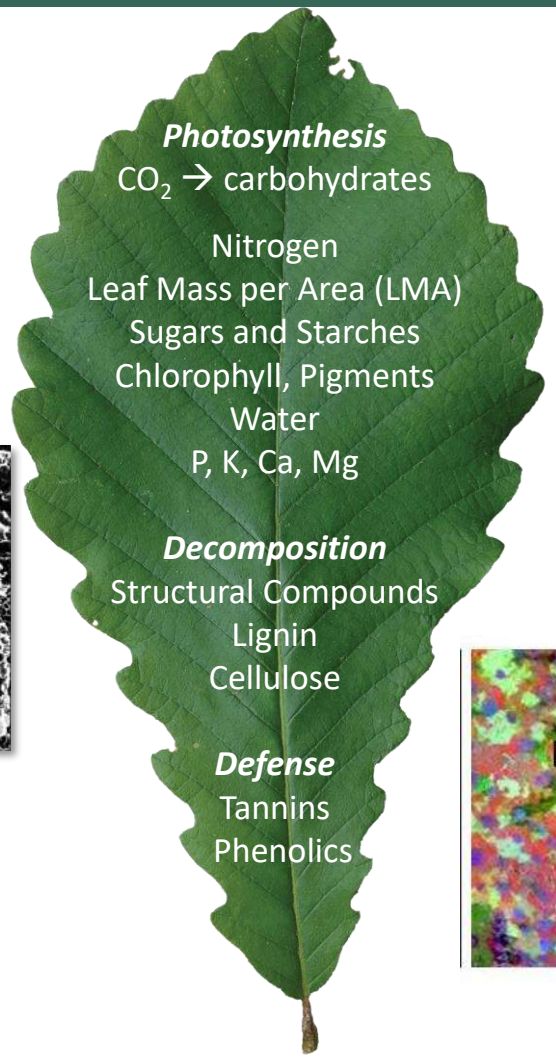
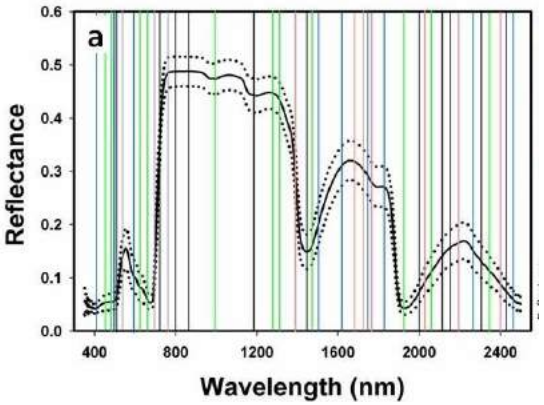
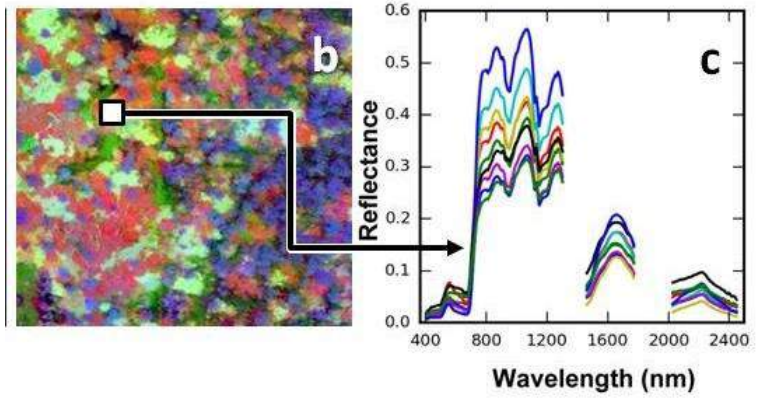


Figure 1



Ecosystem Structure and Function



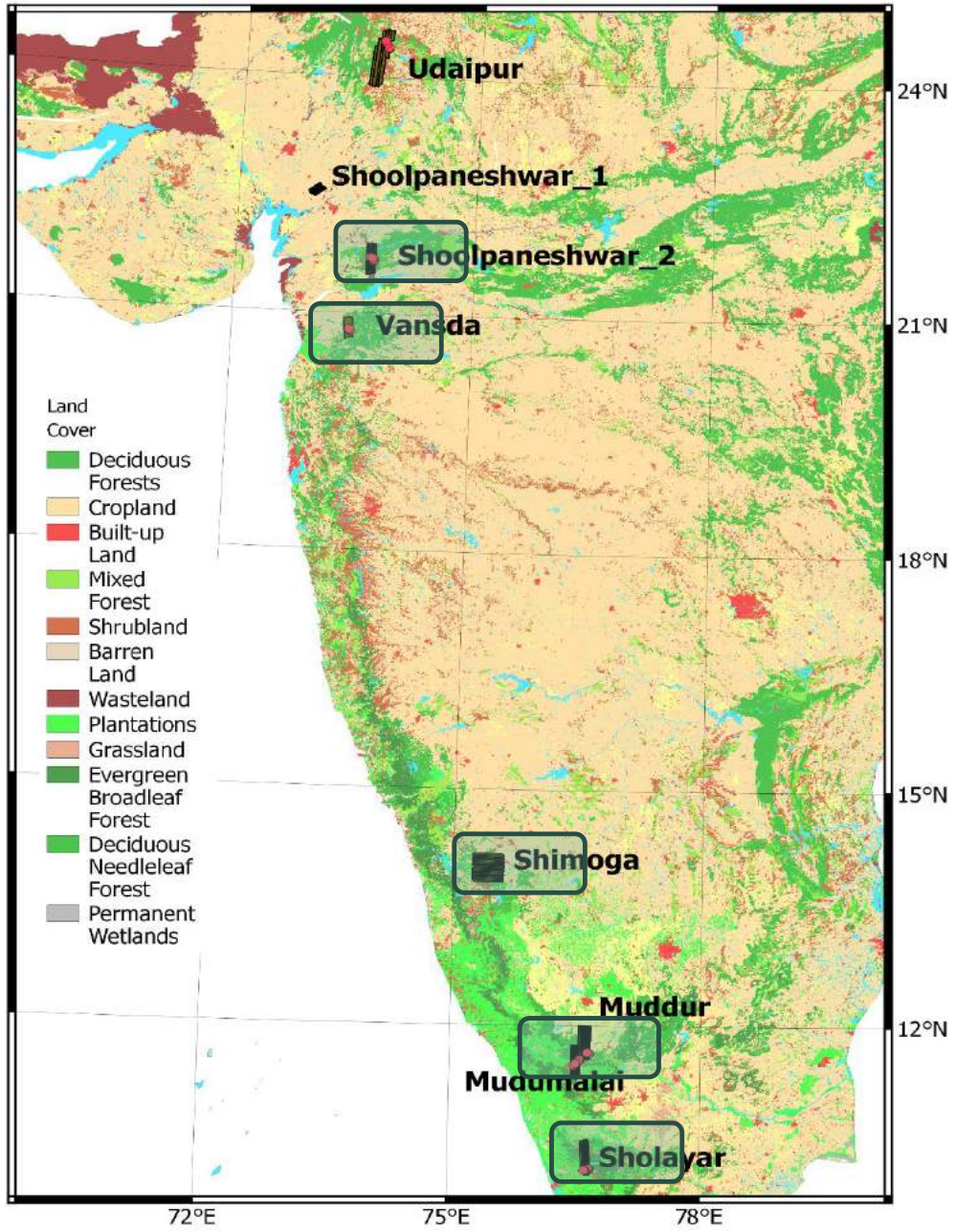


OVERVIEW

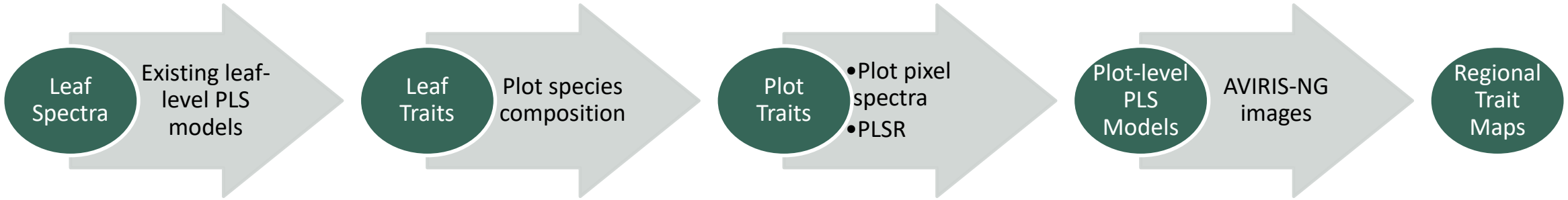
- Study area and data collection
- Mapping traits for the study area using AVIRIS-NG data
- Trait variation along the altitude gradient
- Trait variation along the rainfall gradient

STUDY AREA

Site	PFT	Flight Date	NO. of Field Plots	Sampling Date
Udaipur	DBF/MIX	20160202 20160203	11	20180128
Shoolpaneshwar_1	CROP	20160208	N/A	N/A
Shoolpaneshwar_2	DBF/MIX	20160208	34	20180122
Vansda	DBF/CROP	20160209	17	20180119 20180120
Shimoga	EBF/DBF/CROP	20160101 20160102	N/A	N/A
Muddur	DBF	20160110	2	20180131
Mudumalai	EBF/DBF	20160105	4	20180201 20180202
Sholayar	EBF/DBF	20160107	23	20180203 20180204

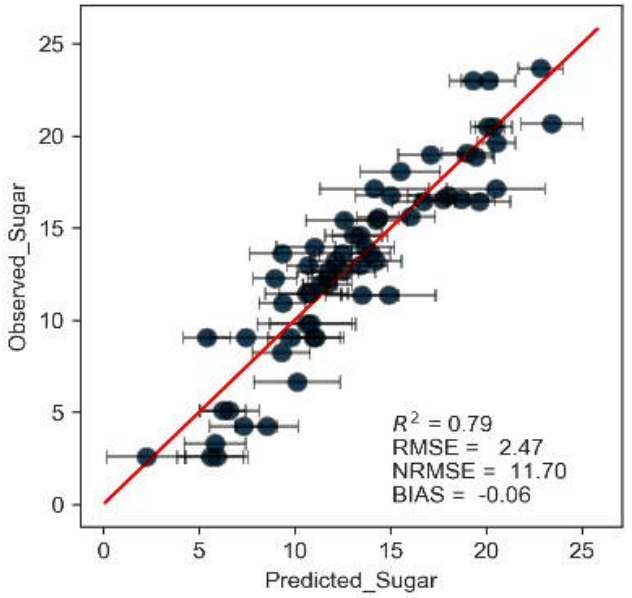


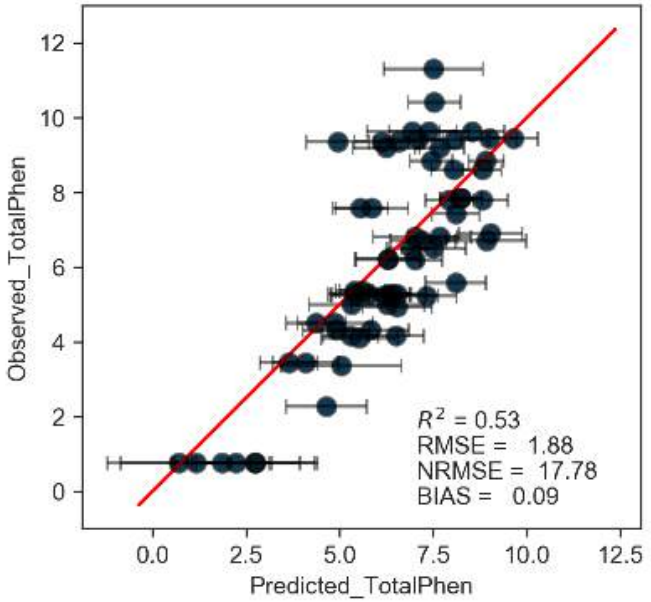
MAPPING TRAITS FOR THE STUDY AREA

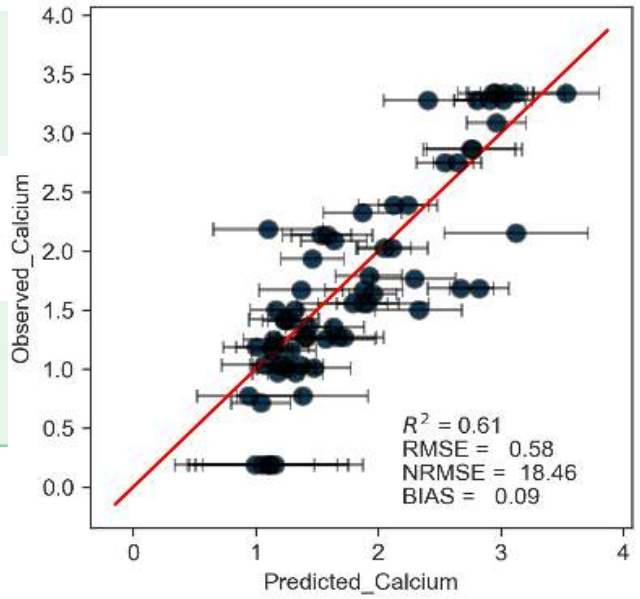


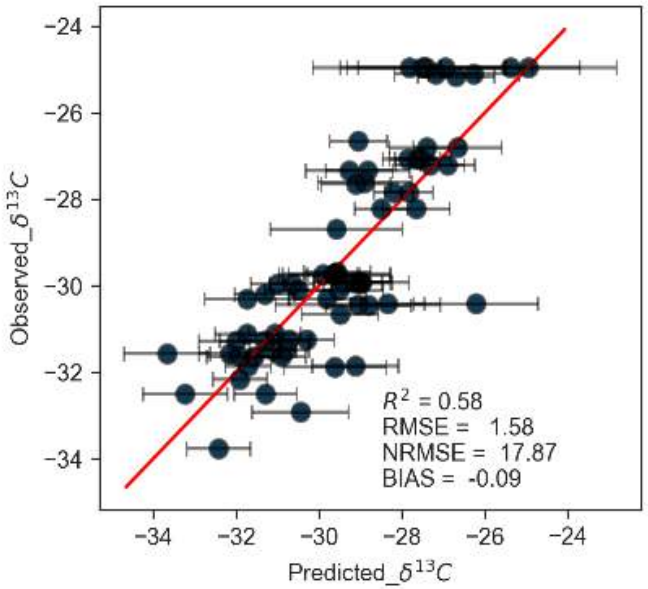
MODEL PERFORMANCE

Trait	Calibration		Validation	
	R^2	RMSE	R^2	RMSE
Sugars (%dw)	0.9 (0.026)	1.65 (0.19)	0.67 (0.082)	3.09 (0.44)
Total phenolics (%dw)	0.58 (0.061)	1.54 (0.125)	0.51 (0.13)	2.12 (0.33)
Calcium (%dw)	0.78 (0.047)	0.39 (0.04)	0.5 (0.11)	0.71 (0.11)
$\delta^{13}C$ (‰)	0.76 (0.06)	1.09 (0.135)	0.48 (0.14)	1.9 (0.3)



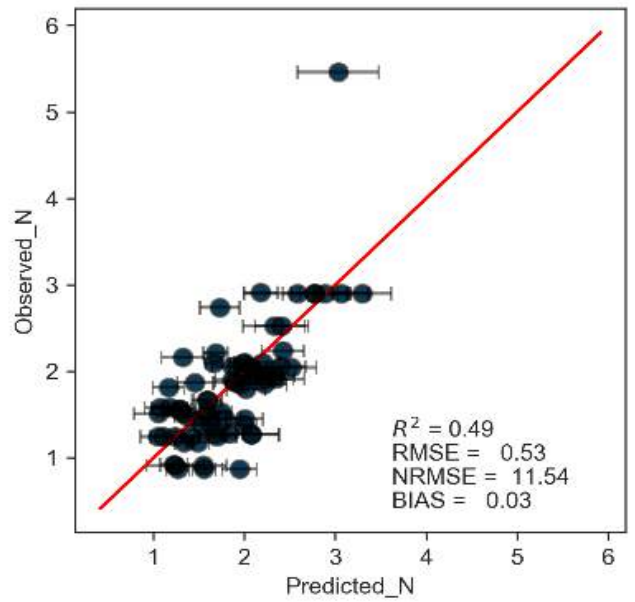


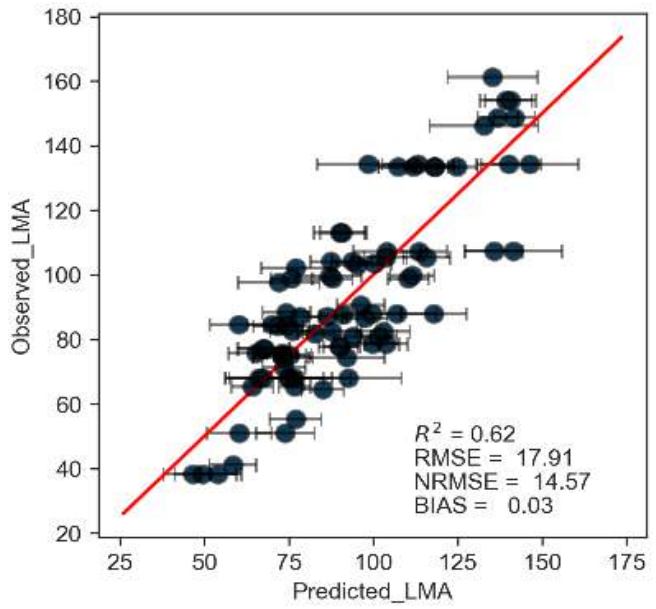


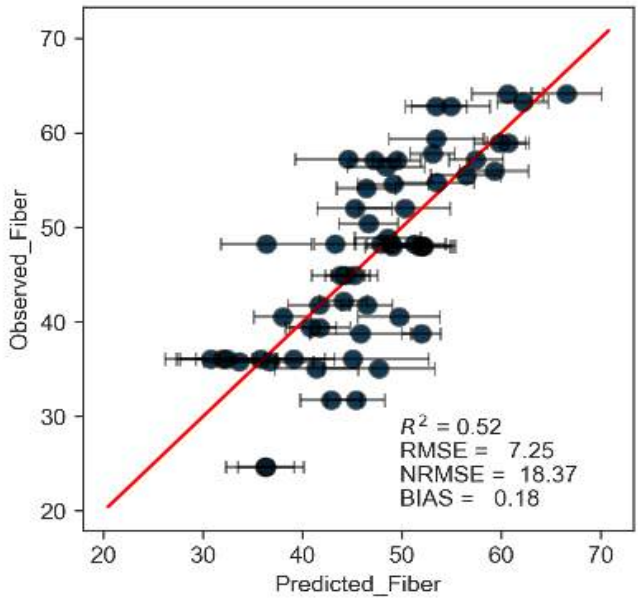


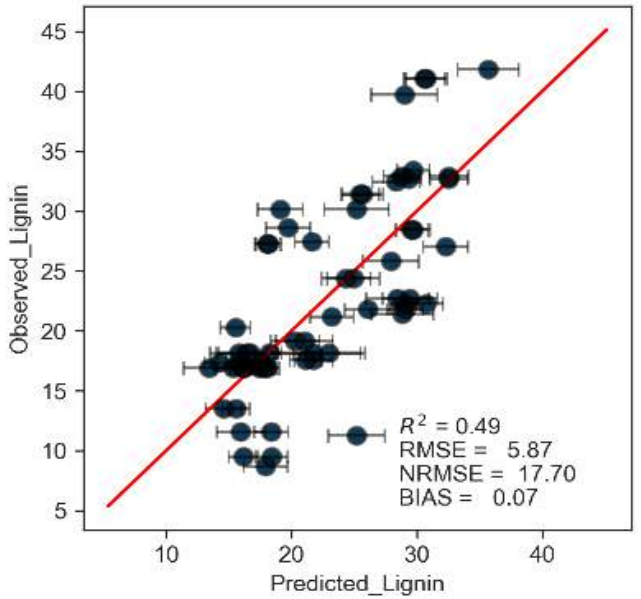
MODEL PERFORMANCE

Trait	Calibration		Validation	
	R^2	RMSE	R^2	RMSE
N (%dw)	0.54 (0.052)	0.47 (0.10)	0.50 (0.08)	0.56 (0.10)
LMA (g/m^2)	0.75 (0.042)	14.43 (1.07)	0.52 (0.072)	20.62 (2.09)
Fiber (%dw)	0.66 (0.064)	5.58 (0.55)	0.43 (0.08)	8.45 (0.99)
Lignin (%dw)	0.54 (0.06)	5.61 (0.41)	0.45 (0.07)	6.05 (0.53)



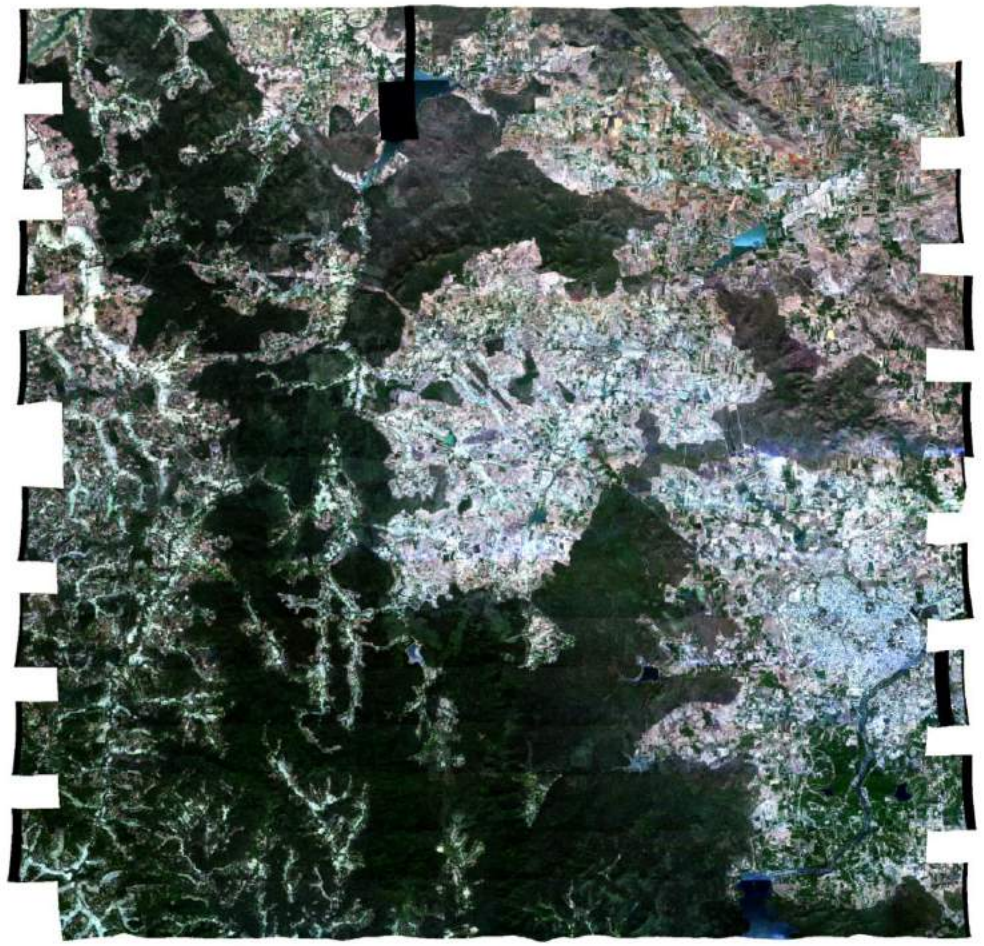






Sholayar

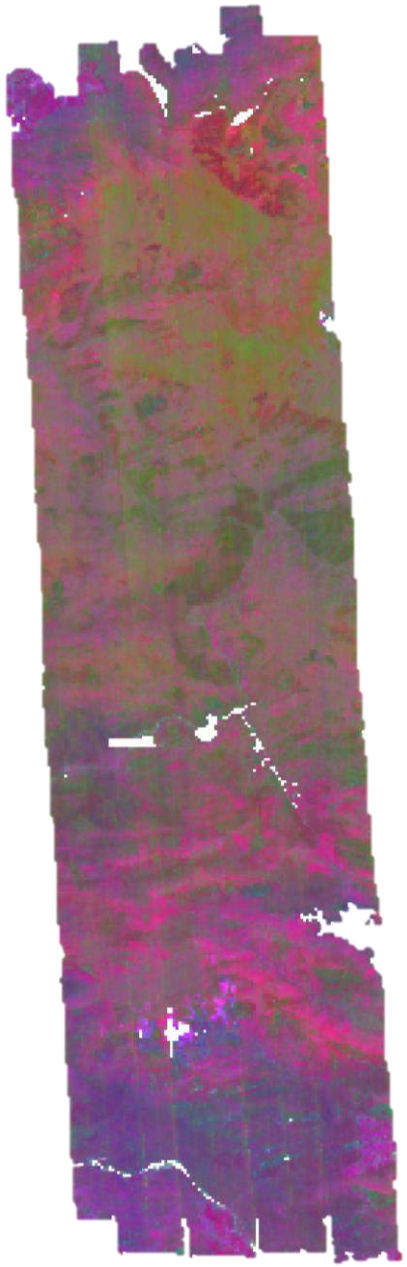
Mudumalai



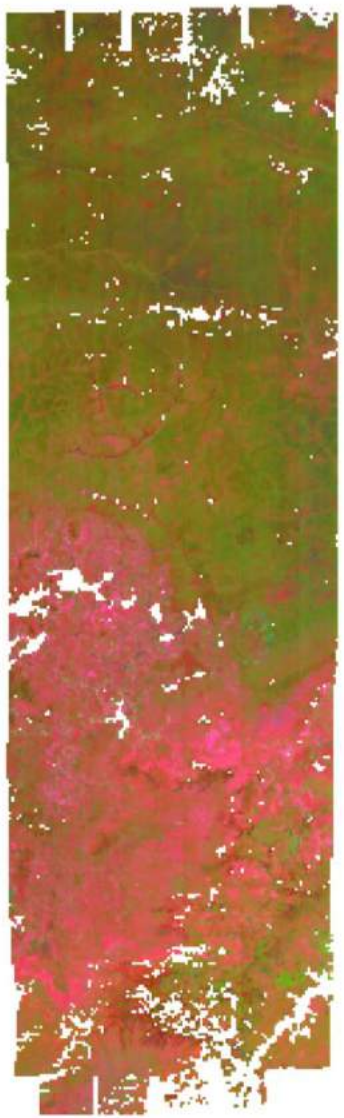
Shimoga

2.5 0 2.5 5 7.5 10 km

True color composition of three heavily vegetated sites



Sholayar



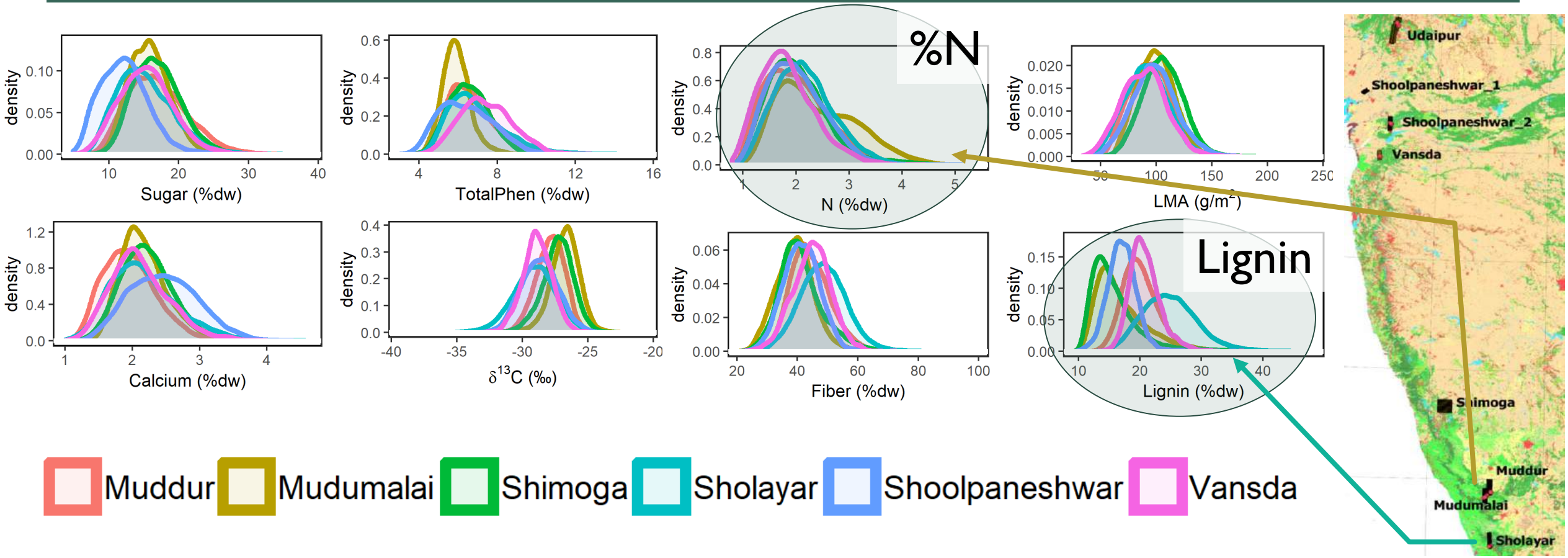
Mudumalai

Shimoga

2.5 0 2.5 5 7.5 10 km

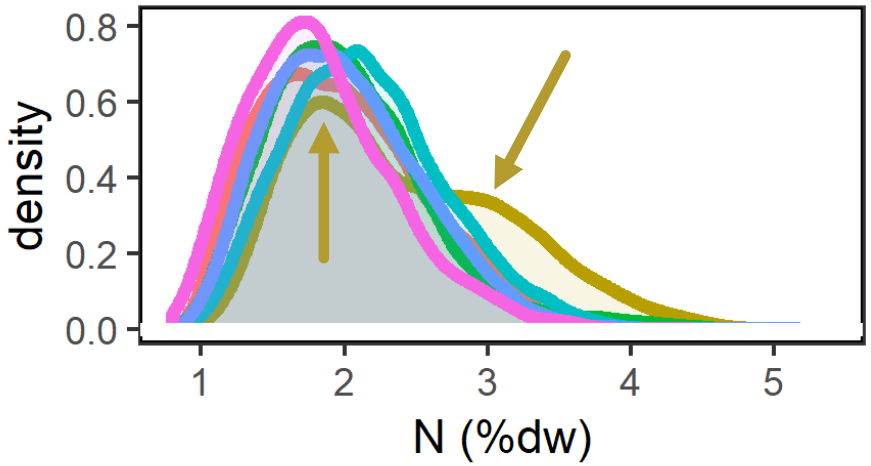
Trait composition with following ranges:
LMA: 30~200 ; N: 0~4; Lignin: 10~45

TRAIT DISTRIBUTION FOR DIFFERENT SITES



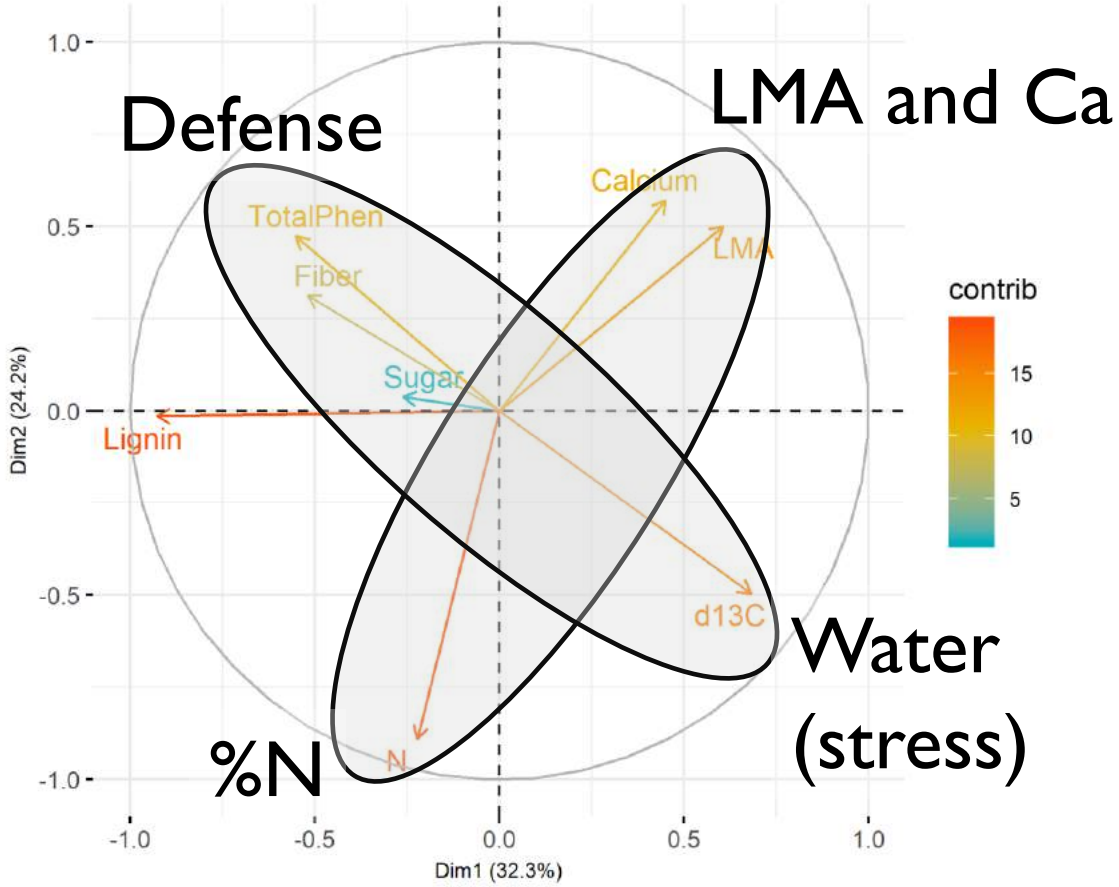
Mudumalai

High %nitrogen in tea plantation

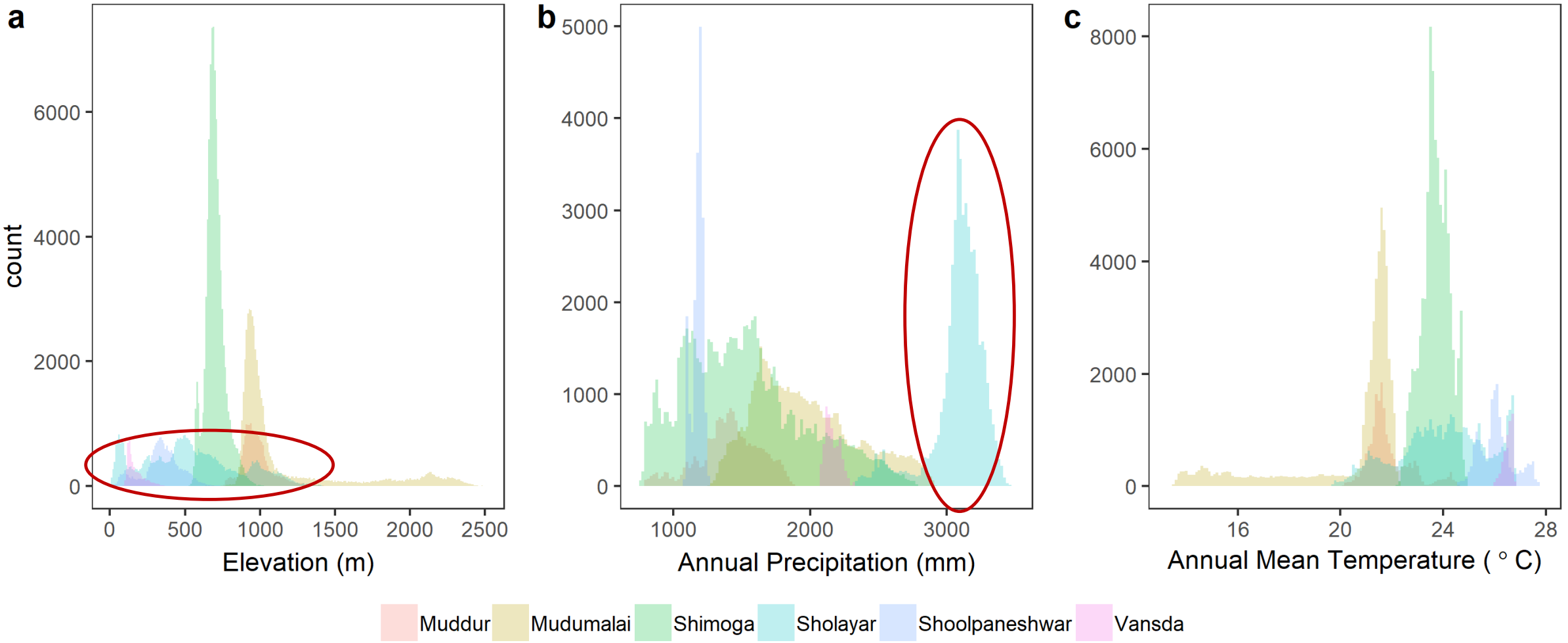


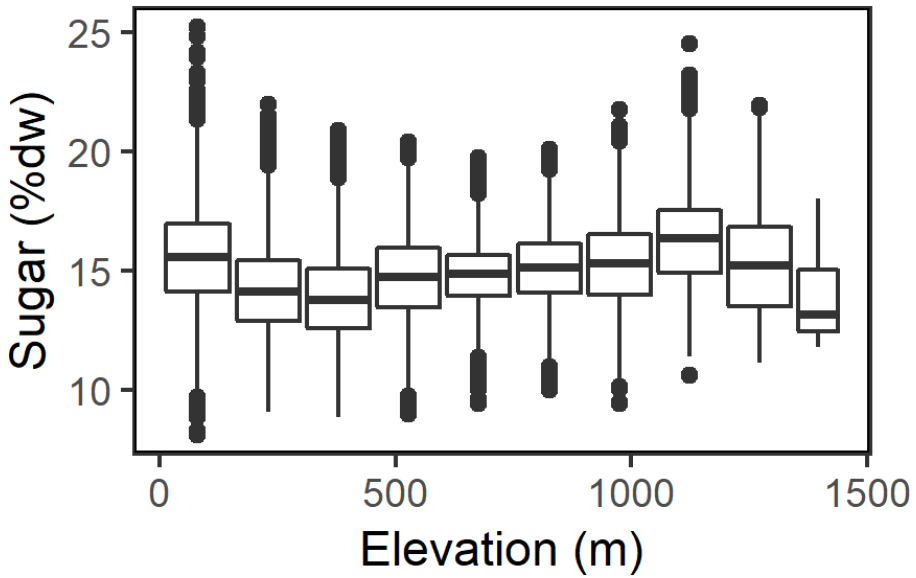
TRAIT SPACE: RELATIONSHIPS AMONG TRAITS

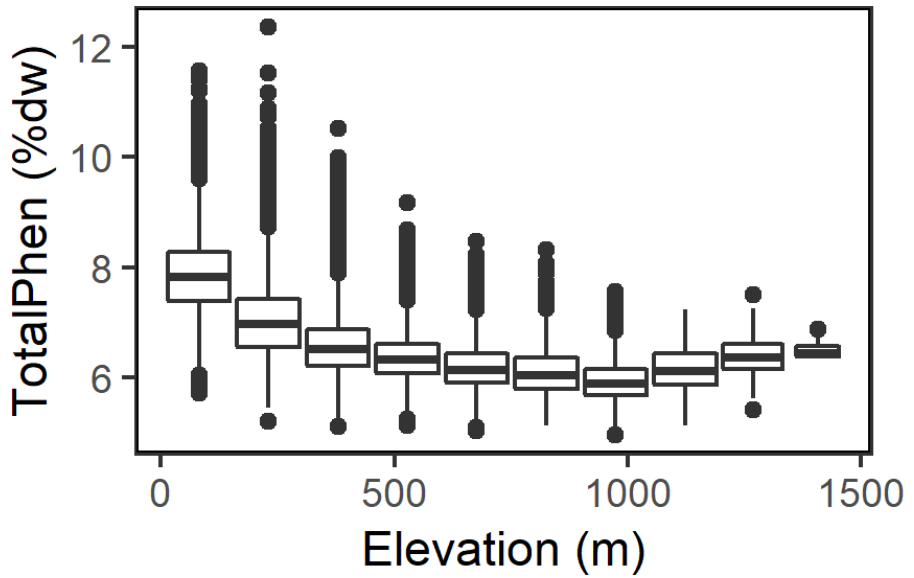
Tradeoffs related to photosynthesis and construction

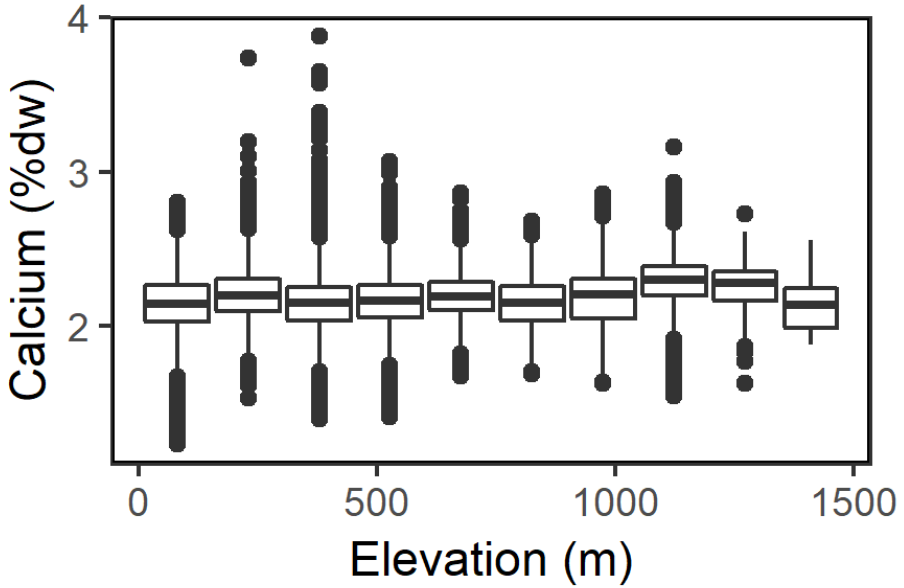


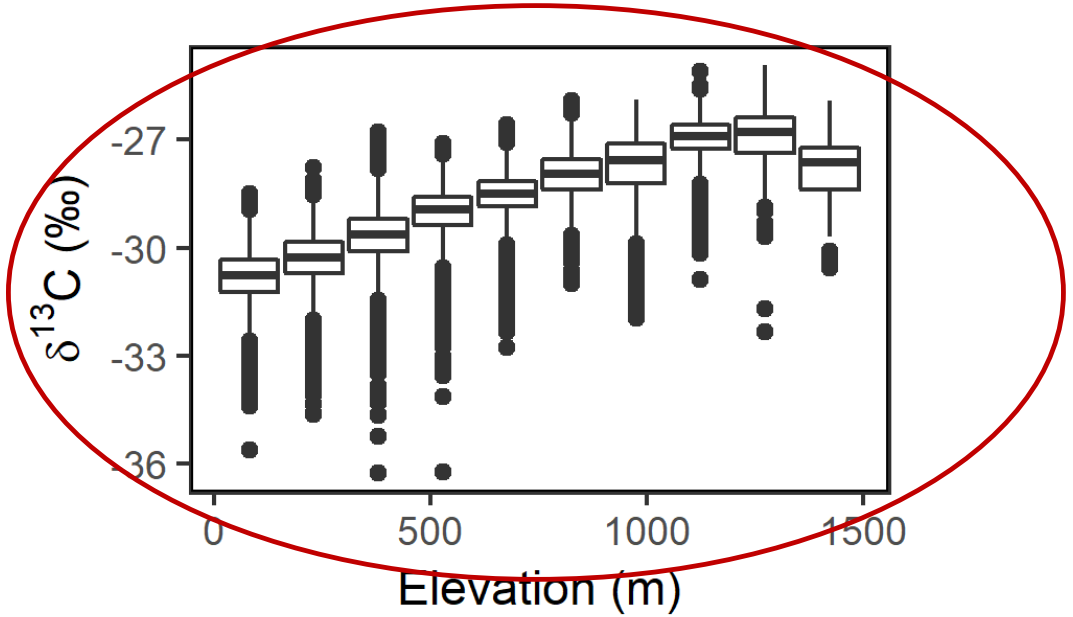
THE ALTITUDINAL TRENDS OF TRAITS:
SHOLAYAR EXAMPLE (LARGE ELEVATION RANGE)

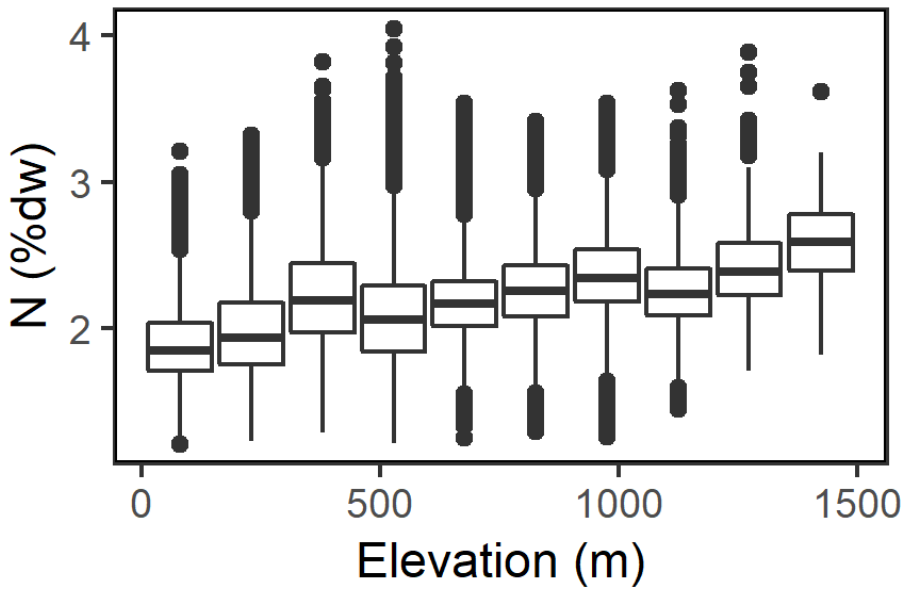


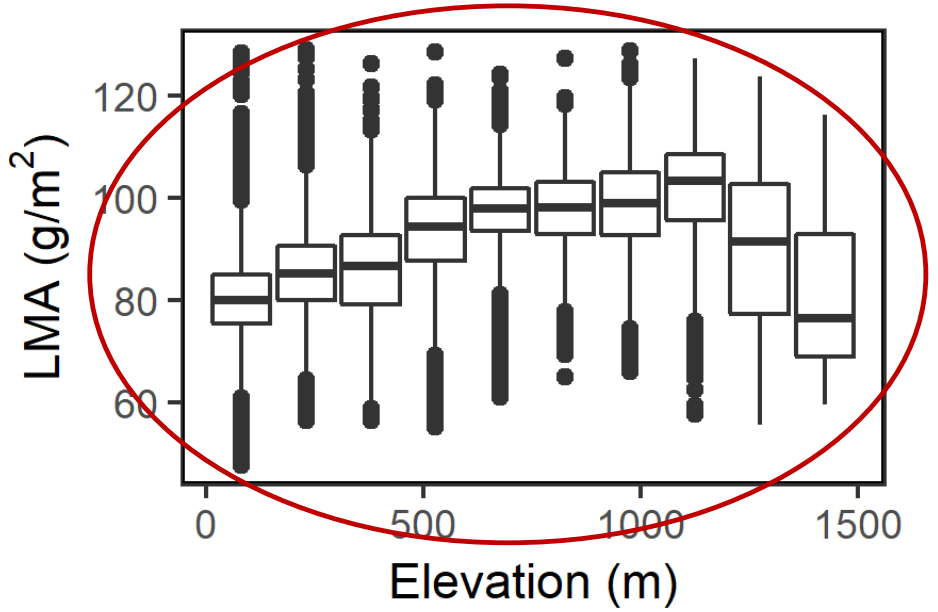

Sugar (%dw)
25
20
15
10
0
500
1000
1500
Elevation (m)


TotalPhen (%dw)
12
10
8
6
0
500
1000
1500
Elevation (m)

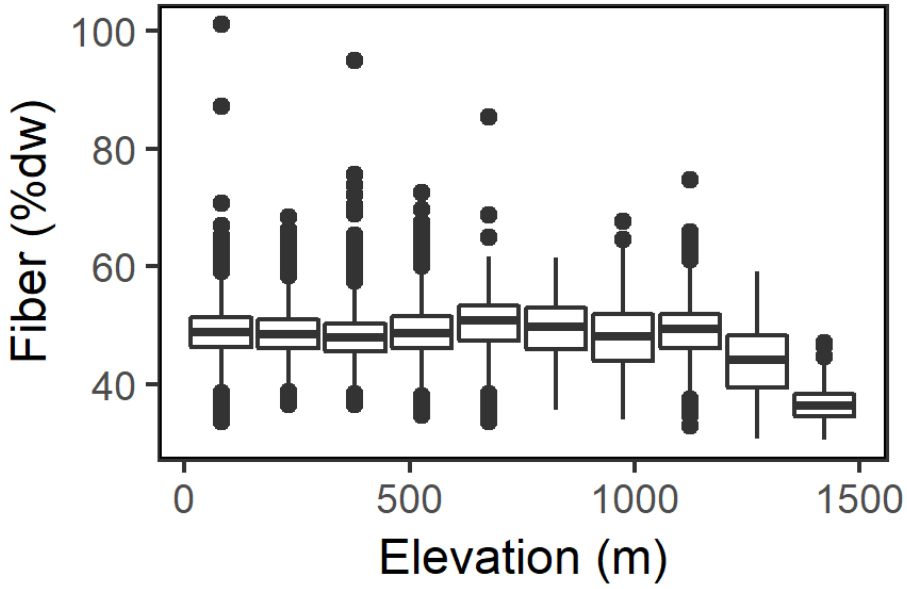

Calcium (%dw)
4
3
2
0
500
1000
1500
Elevation (m)

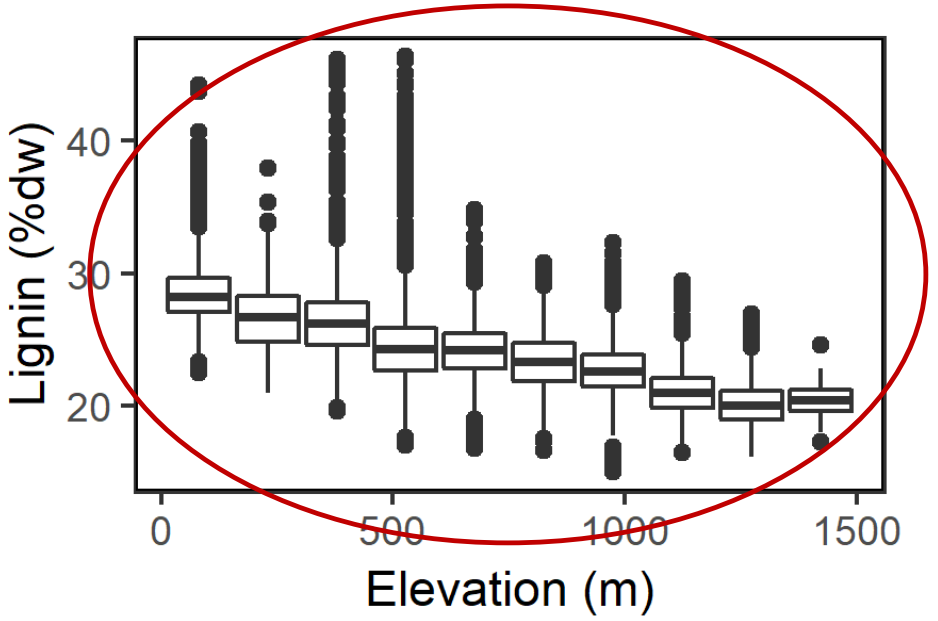

δ13C (‰)
-27
-30
-33
-36
0
500
1000
1500
Elevation (m)



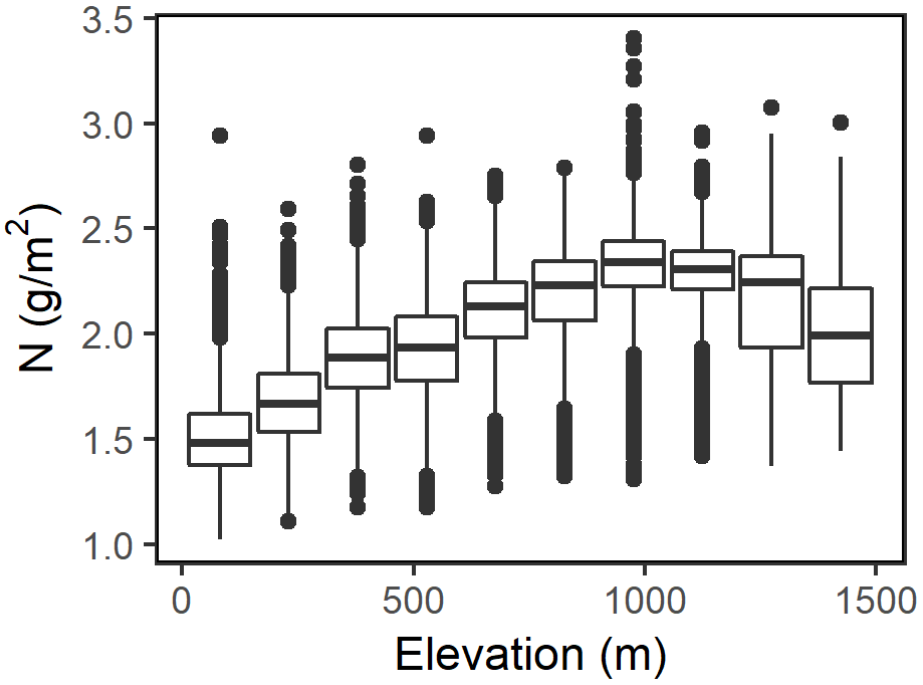


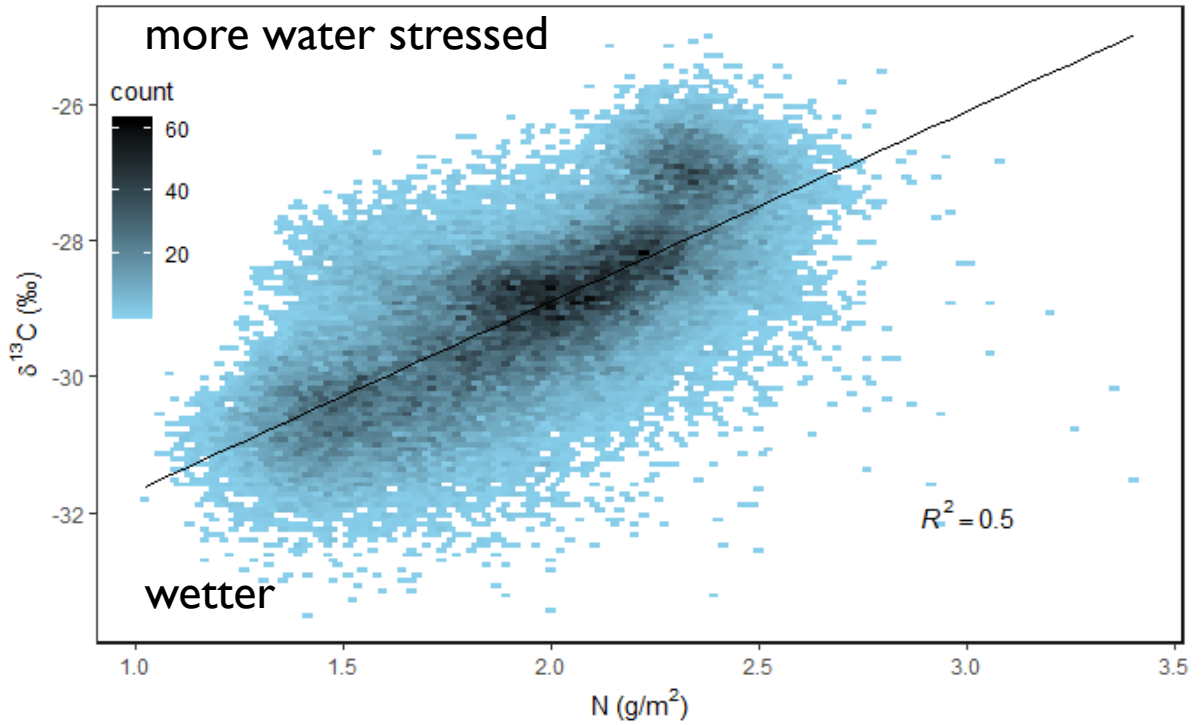
%N & LMA: Higher photosynthetic efficiency at higher elevations?
Also also explains increasing δ13C.





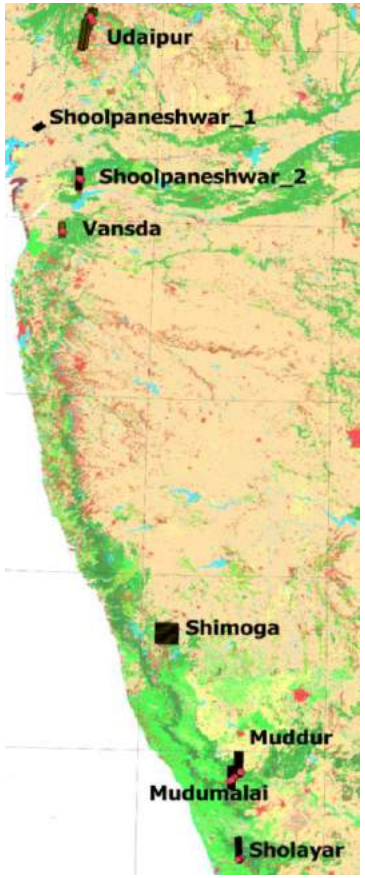
Lignin
Also observed by Asner et al. (2016) in tropics and Richardson (2014) in boreal forests.



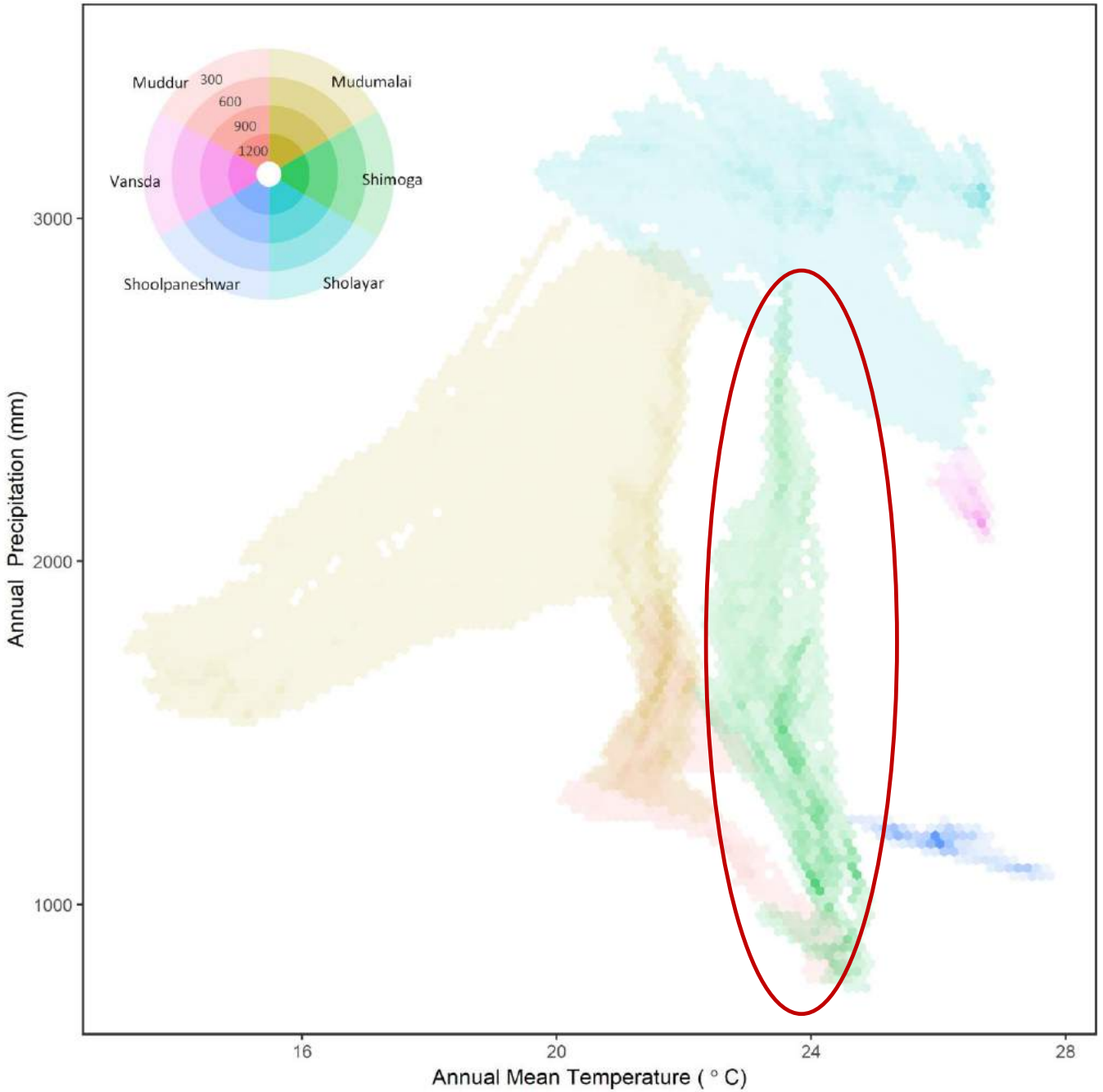


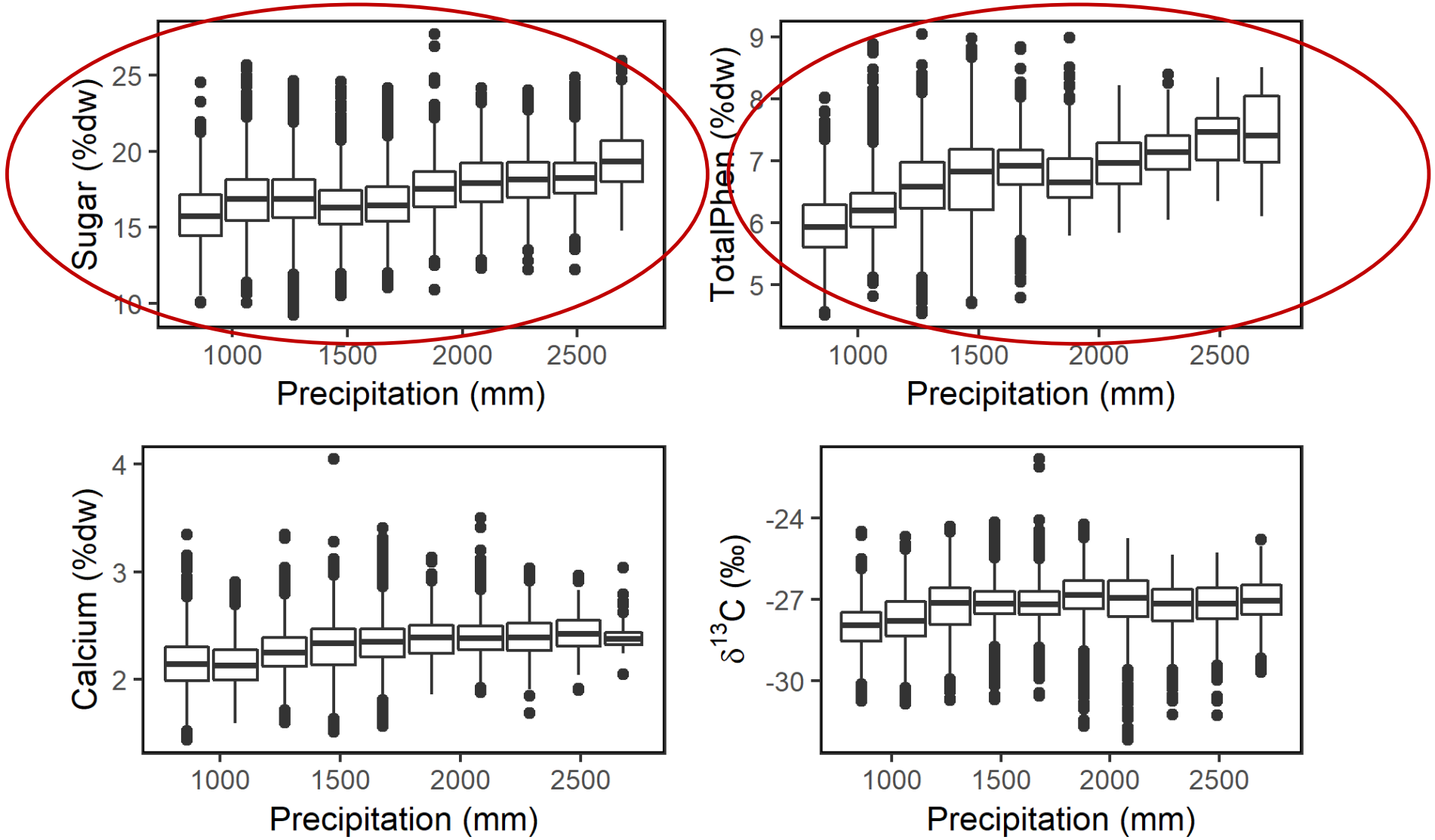
- $\delta^{13}C$ is an indicator of water status.
- Potentially more useful than water content or EWT.
- Isotopic fractionation associated with differential diffusivities of $^{13}CO_2$ versus $^{12}CO_2$ in the air and stomata (higher WUE).

PRECIPITATION GRADIENT: SHIMOGA

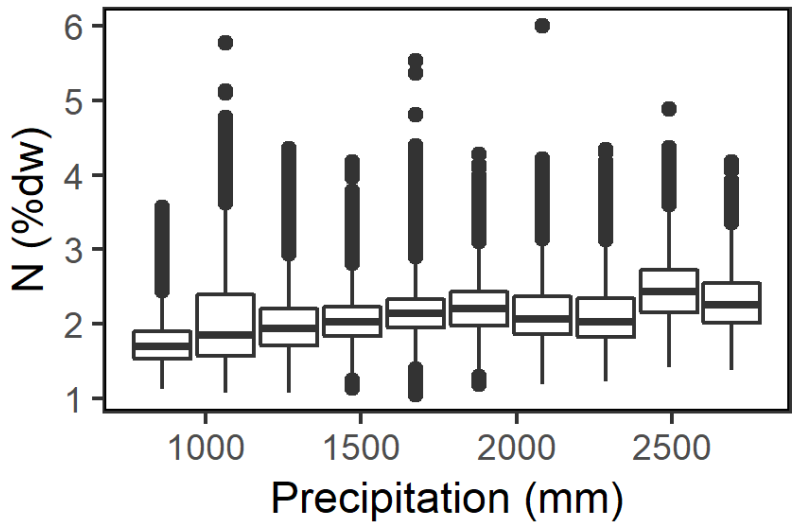


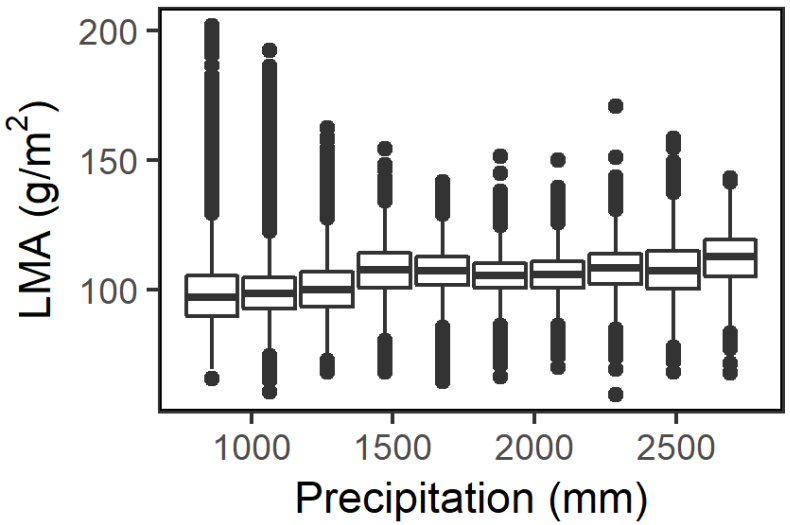
T-P space for 6 sites based on 100m resolution climate data. Shades of color indicate number of pixels for a given T-P combination.

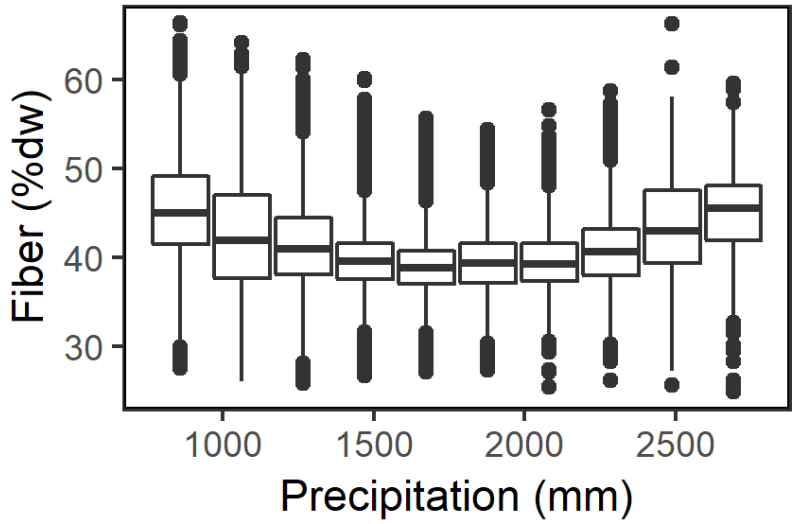


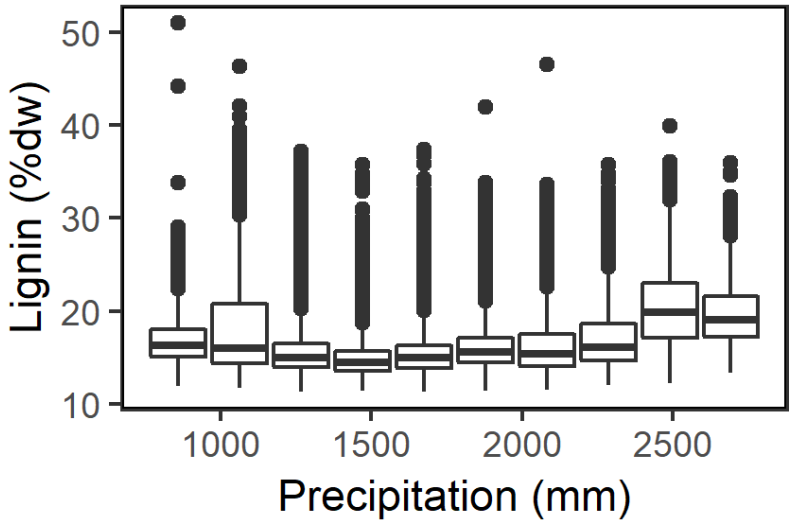


Sugar and phenolics production increase with precipitation: less water stressed plants can allocate more resources to phenolics (defense) and possibly carbohydrates.

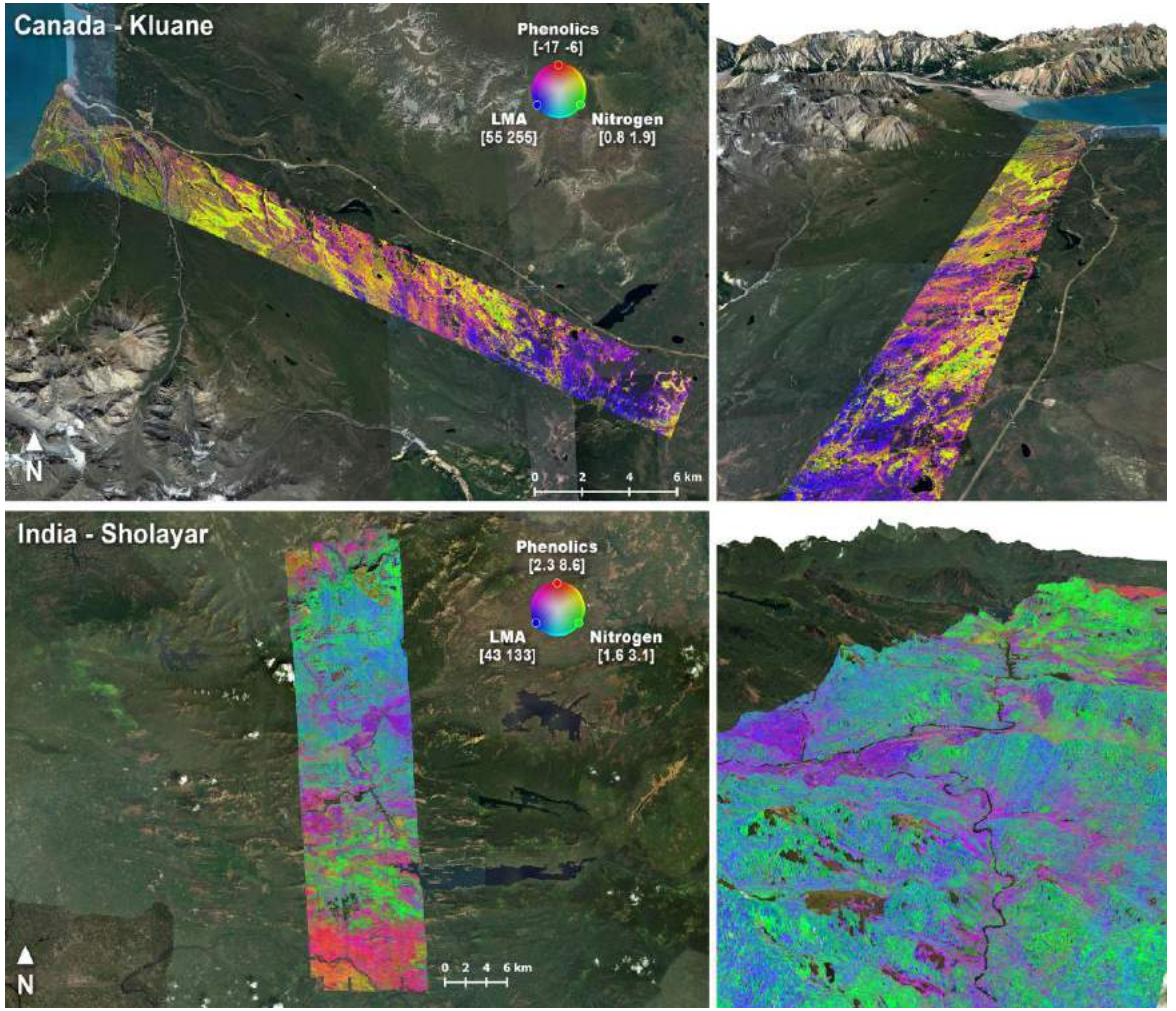

N (%dw)
6
5
4
3
2
1
1000
1500
2000
2500
Precipitation (mm)


LMA (g/m^2)
200
150
100
1000
1500
2000
2500
Precipitation (mm)

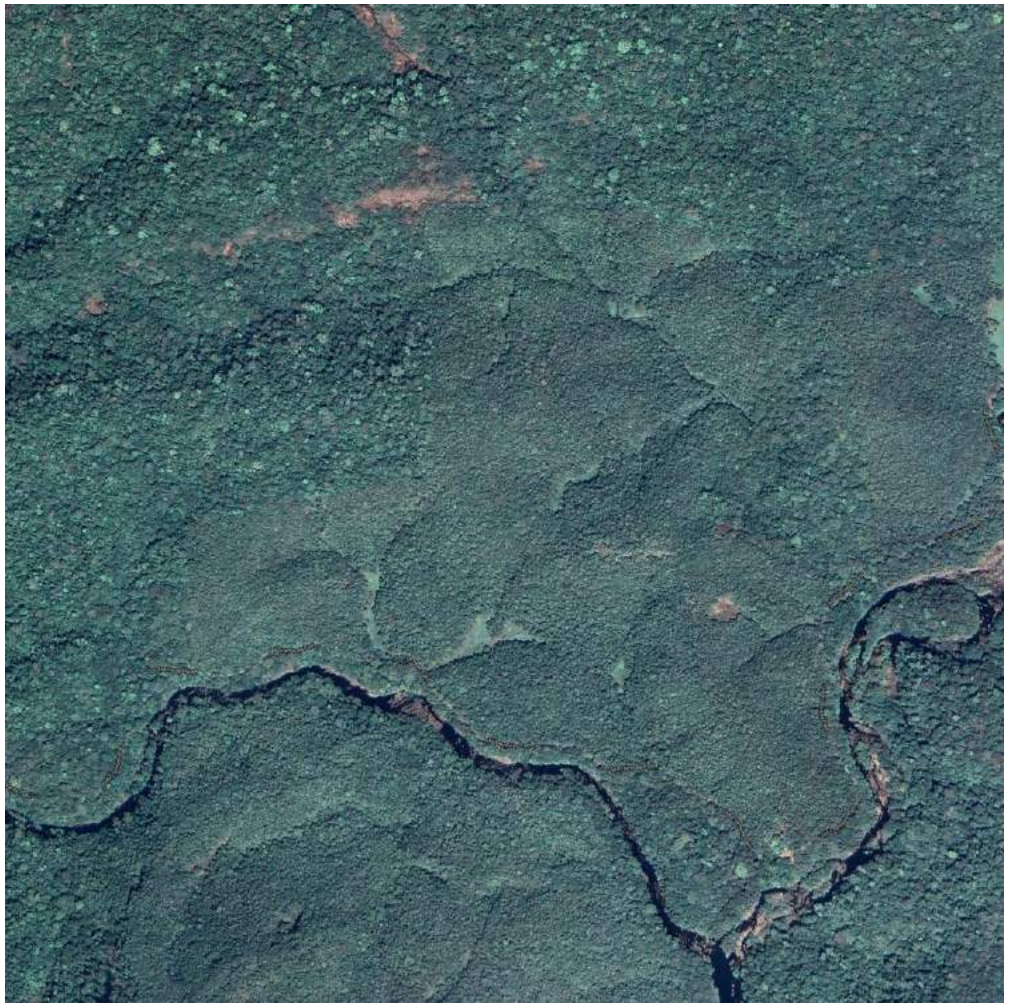

Fiber (%dw)
60
50
40
30
1000
1500
2000
2500
Precipitation (mm)

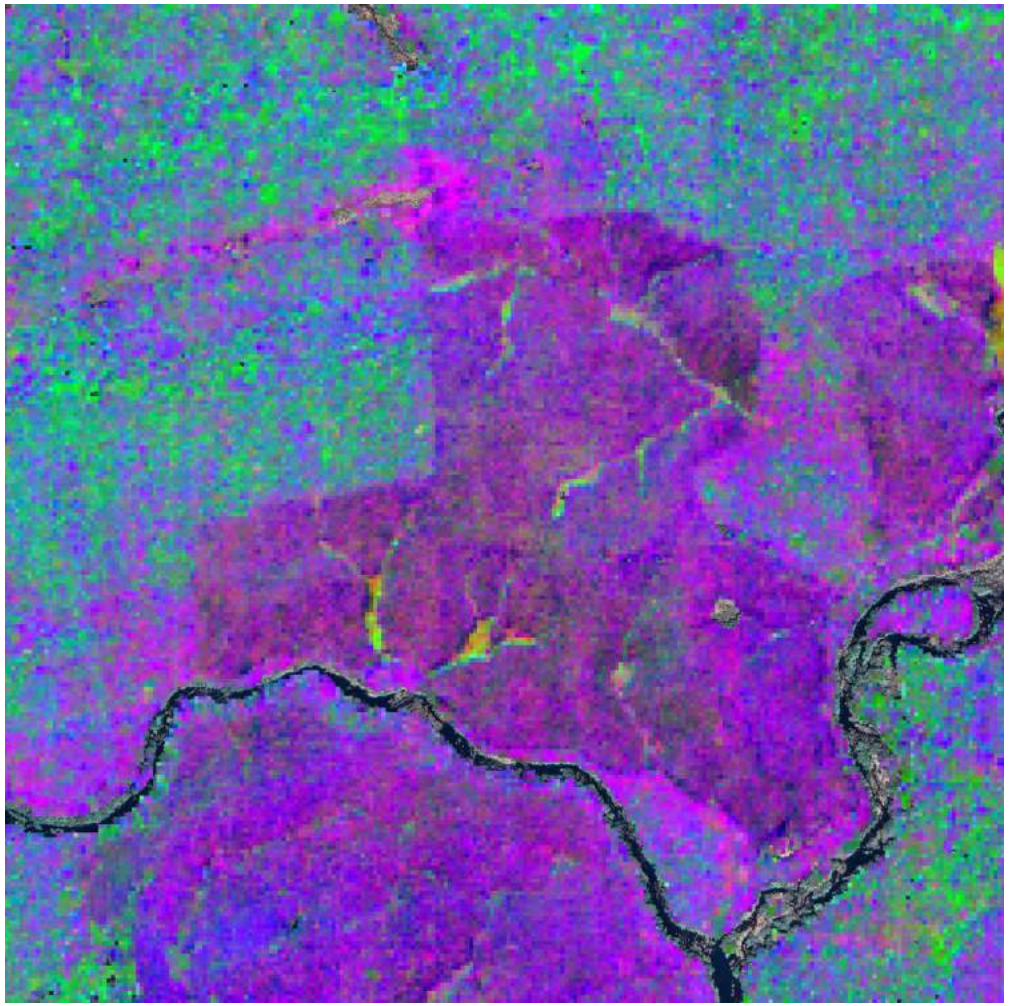

Lignin (%dw)
50
40
30
20
10
1000
1500
2000
2500
Precipitation (mm)

EXTENSION TO FUNCTIONAL DIVERSITY
WITH F. SCHNEIDER & D. SCHIMEL



EXTENSION TO FUNCTIONAL DIVERSITY
WHAT DOES IT MEAN IN HUMAN-DOMINATED LANDSCAPES?





CONCLUSION

- Imaging spectroscopy is an effective tool in trait mapping, especially for areas hard to access.
- PCA of the trait space containing eight traits reveals two major axes: one represents the photosynthetic production and another the allocation of photosynthetic products.
- Combining with other datasets (e.g., DEM and climate data), trait maps can be used to analyze the environmental drivers of trait variance, which will help us understand and predict how traits may vary under dynamic climate scenarios in future.