iufro2019
Curitiba · Brazil
29 SEPT - 5 OCT

XXV IUFRO World Congress | Forest Research and Cooperation for Sustainable Development

Impact of drought on wood chemistry by near infrared hyperspectral imaging

CHAIX Gilles, PIRES FRANCO Mariana, TOMAZELLO FILHO Mario, CHAMBI LEGOAS Roger, PERASSOLO TRISLTZ Fernanda, GORRETTA Nathalie, PASQUINI Celio, VIDAL Cristiane, ROGER Jean-Michel

USP ESALQ

cirad
AGRICULTURAL RESEARCH FOR DEVELOPMENT

Context : Eucalyptus plantations

Tree mortality in commercial plantations due to climatic events

Spatial approaches for:

Genotype x environment interactions and plasticity

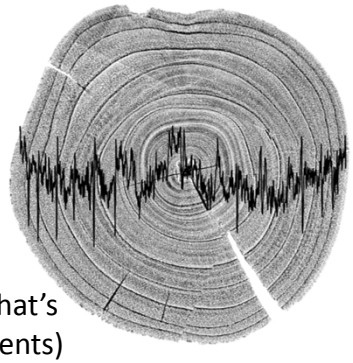
Plastic or not plastic genetic material link to climatic changes and risk of big events

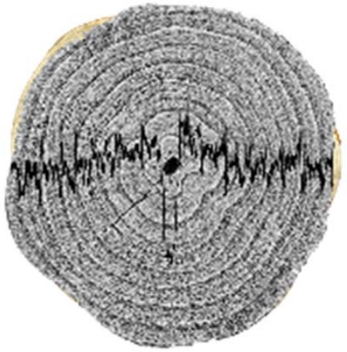
Site 1

Site 2

Drougth stress +++

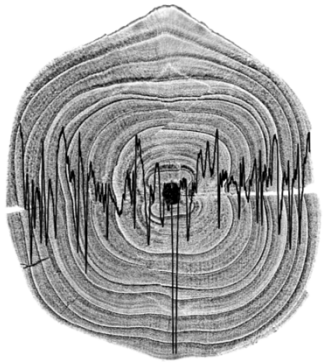
Clone A

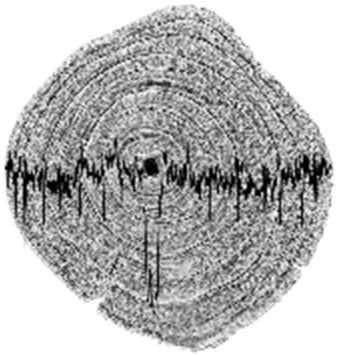




Non-plastic clone, but stable (homogeneity of wood but what's append during big climatic events)

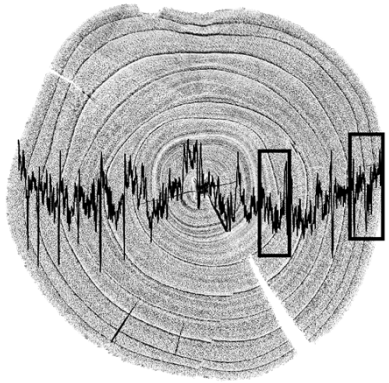
Clone B





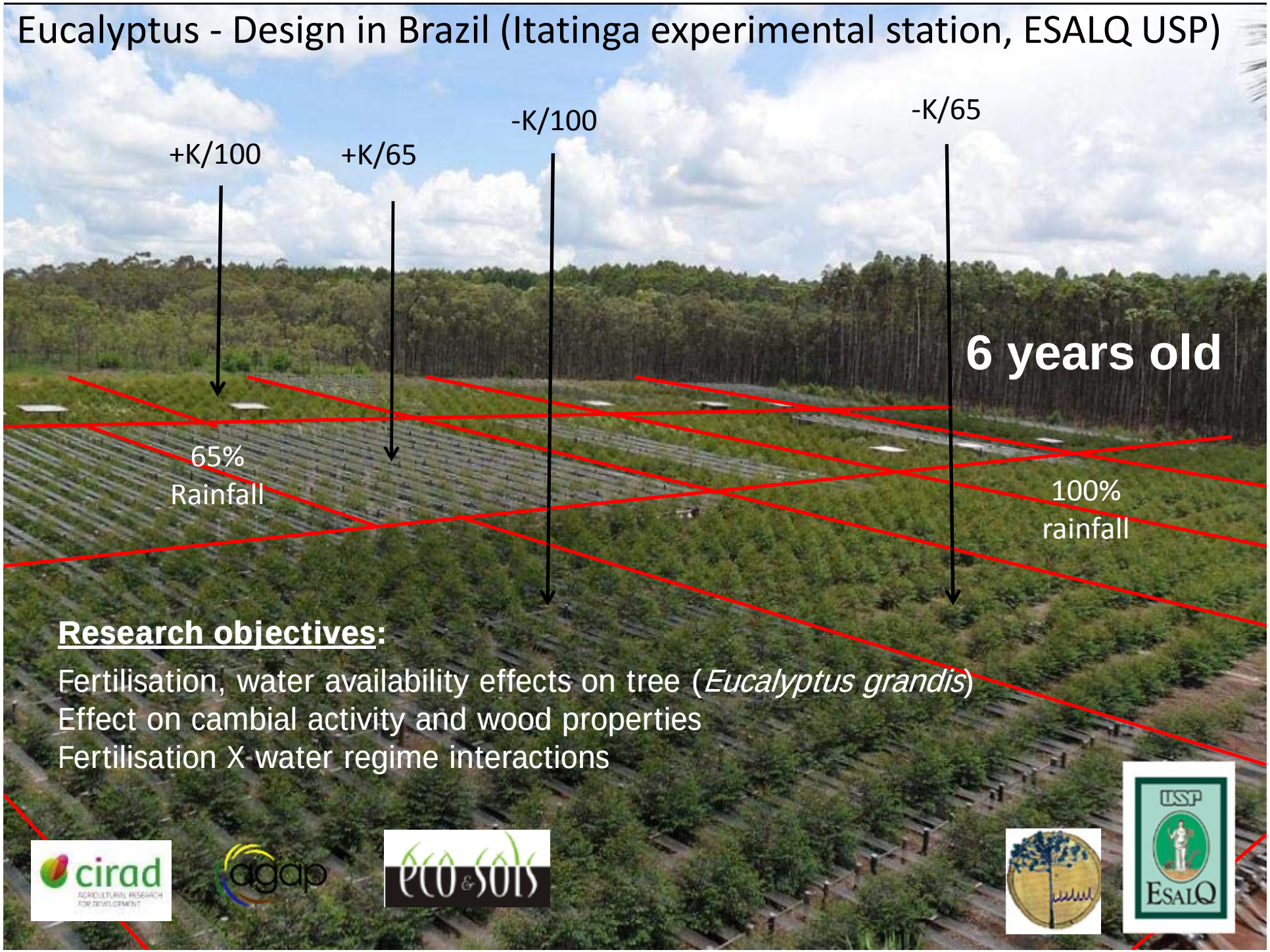
Plastic clone depending of environment (good in changing environments but induce wood heterogeneity)

Early selection efficiency (3-4 y for Eucalyptus)



Impact of water stress on juvenile – adult correlation ???

Eucalyptus - Design in Brazil (Itatinga experimental station, ESALQ USP)



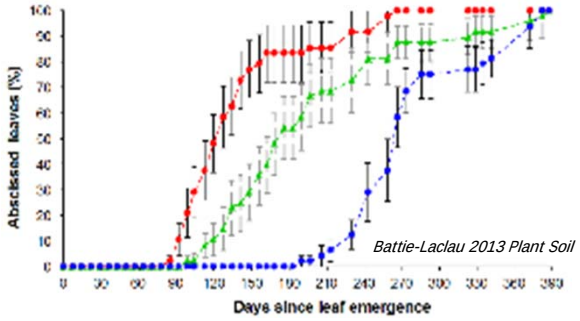
Research objectives:

Fertilisation, water availability effects on tree (*Eucalyptus grandis*)
Effect on cambial activity and wood properties
Fertilisation X water regime interactions

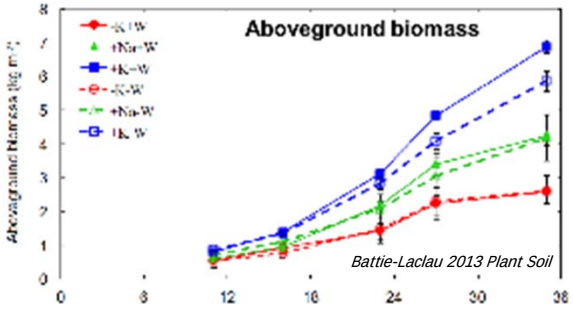
Eucalyptus - Design in Brazil (Itatinga experimental station, ESALQ USP)

Eucalyptus - Design in Brazil (Itatinga experimental station, ESALQ USP)

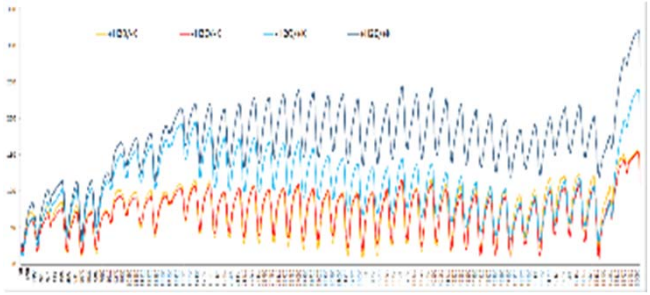
Growth and development are affected by rainfall exclusion and fertilization:



With K: leave life 2 times longer



With K & rainfall exclusion: Biomass 3 times bigger



Cambial activity (secondary growth) affected according to fertilization and water availability

Environmental effect on wood heterogeneity from pith to bark ?

Consequences on:

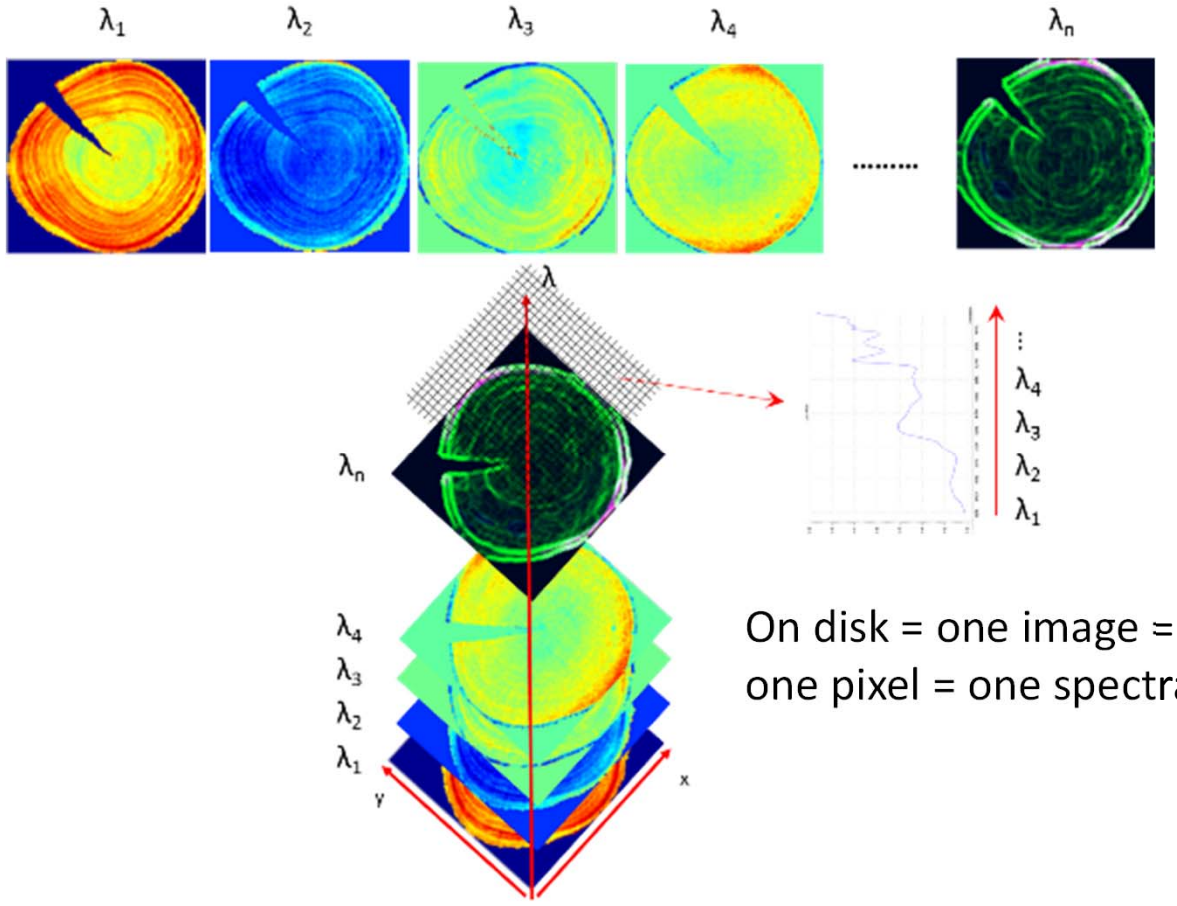
- Wood quality
- Timber yield
- Drying

To explore radial and longitudinal variabilities of wood properties

How to reveal radial variability?

One option is Hyperspectral imaging in NIR region (1000-2500 nm)

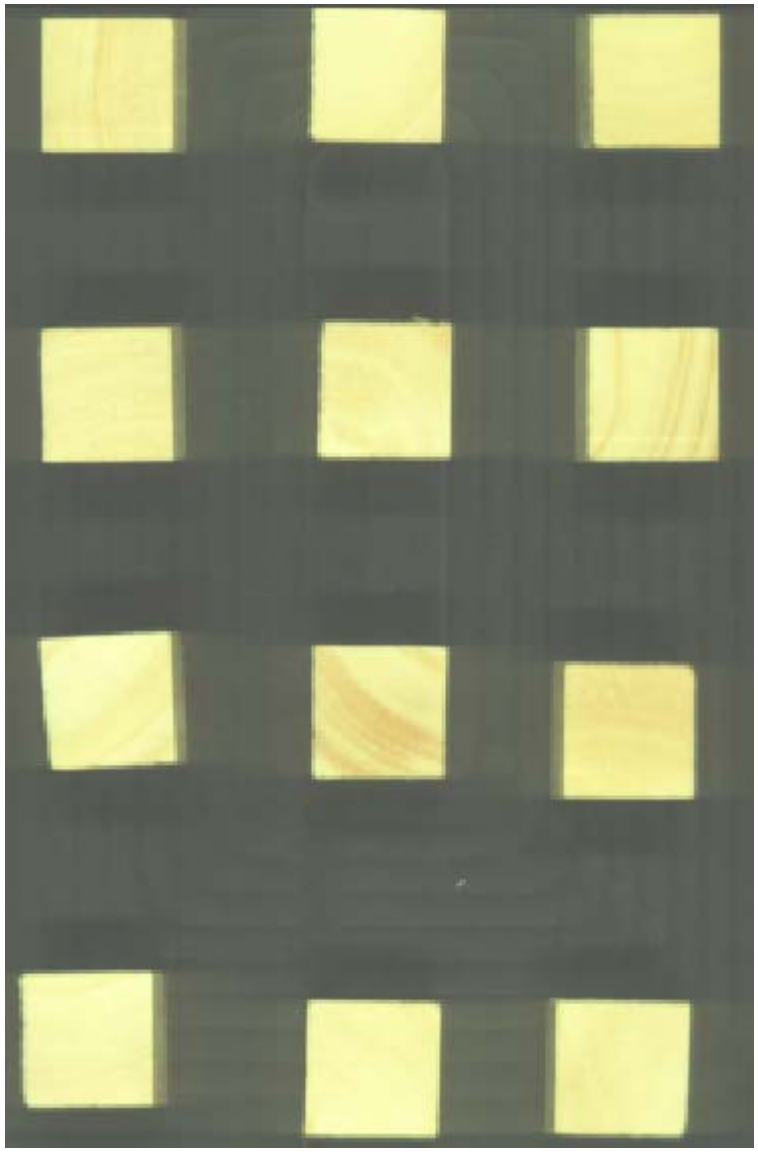
one image for each wavelenght



On disk = one image = 30 000 spectra
one pixel = one spectra

With NIR model we'll predict each pixel
Rebuilt image for each propertie predicted

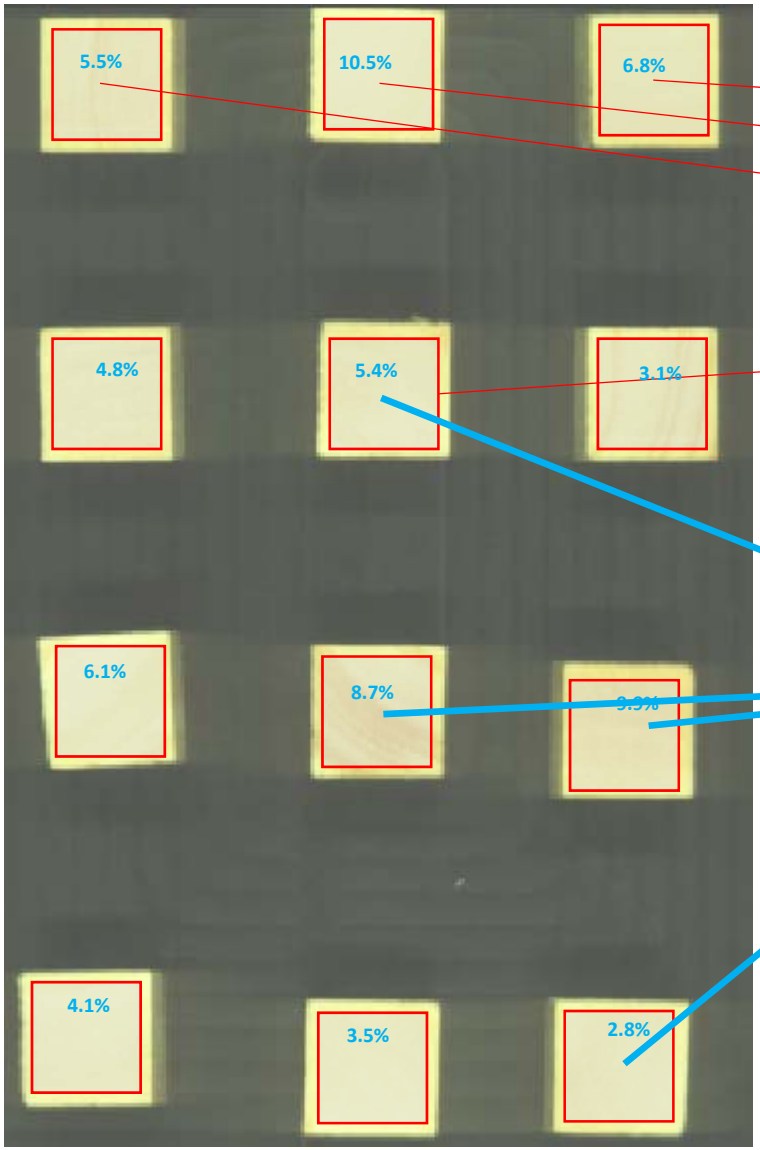
Calibration of HSI camera for prediction of solid wood



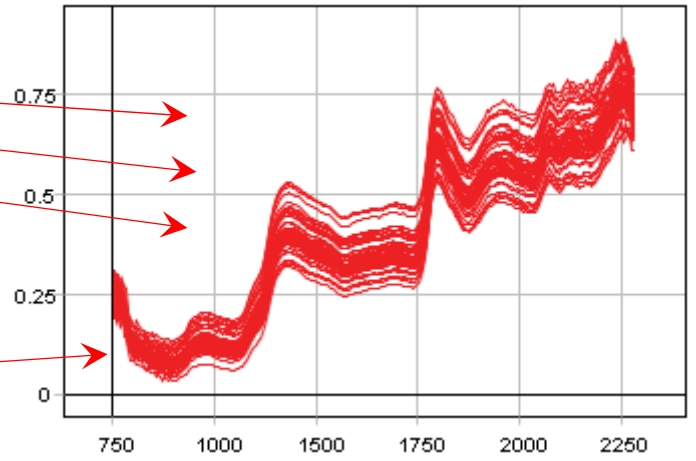
HSI, SPECIM, pixel size 625x625µm, 900-2500 nm, 255 wavelength

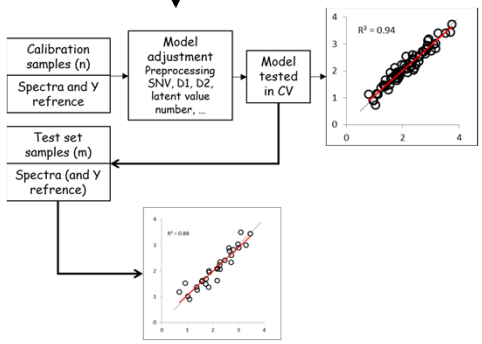
Calibration process of HSI camera for prediction of solid wood

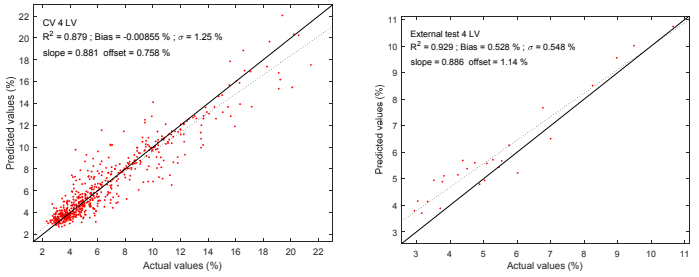
1 sample =1 000 pxels =1 000 spectra



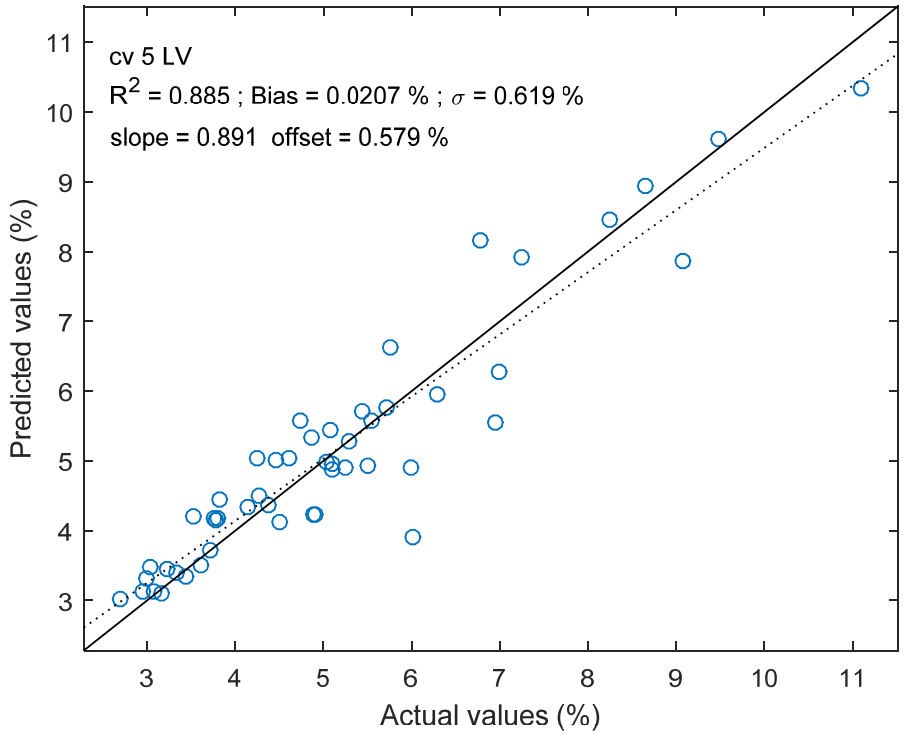
Mean spectra







Calibration results (total extractive content) for HIS camera



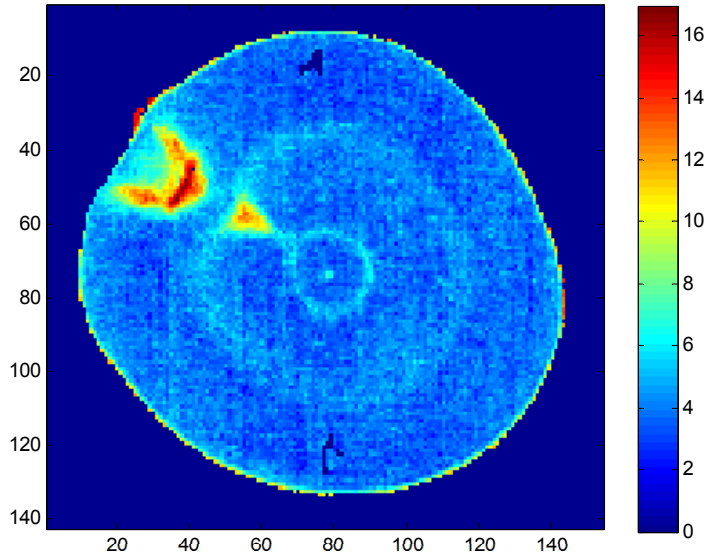
extractives content %	N	LV	R^2cv	RMSECV	%RMSEV	R^2	RMSEP	%RMSEP	%SEL
Cross-validation	50	5	0.885	0.619	12.1				
Cross-validation	37	5	0.834	0.727	14.8				11.6
Validation by test set	13	5				0.764	0.895	15.8	

Prediction results (total extractive content)

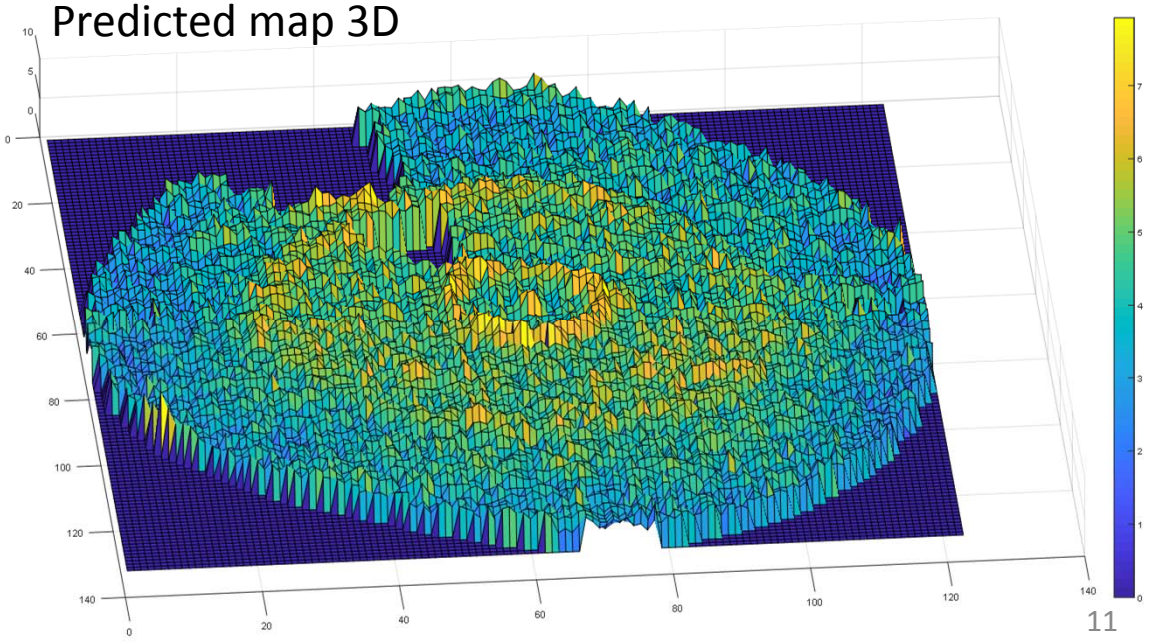
Image aquisition on wood disk

Diameter disk 15 cm = 30 000 pixels = 30 000 spectra

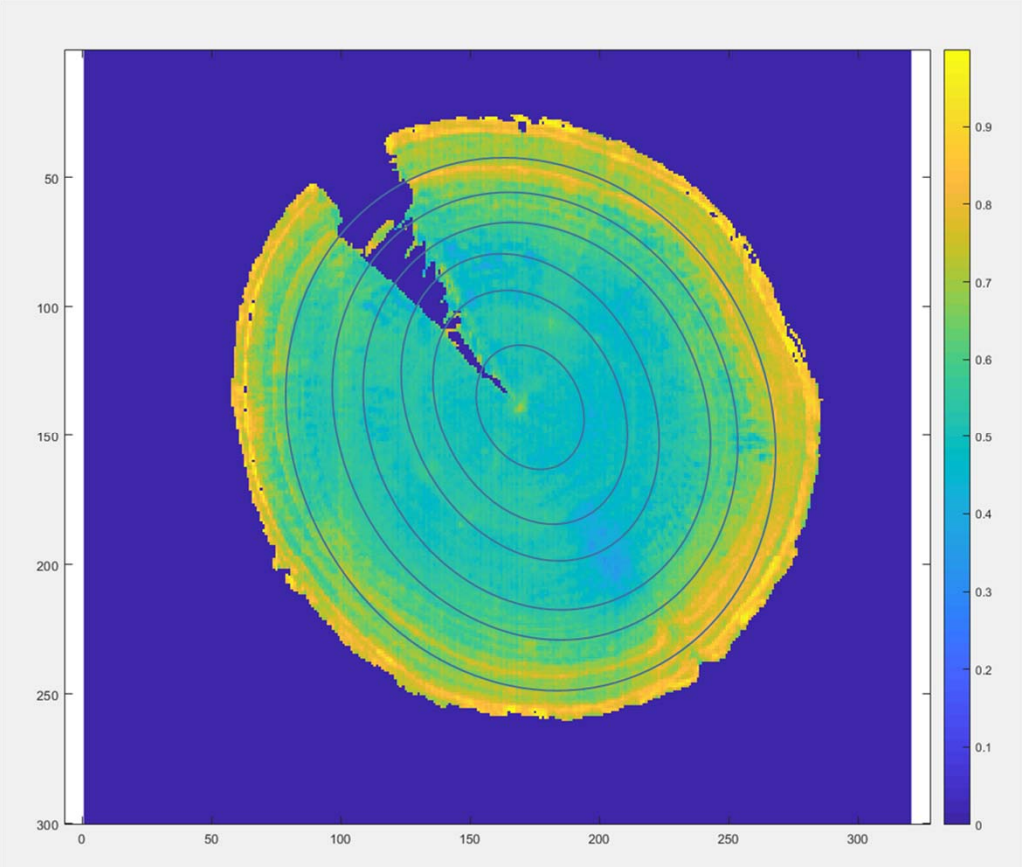
Predicted map 2D



Predicted map 3D



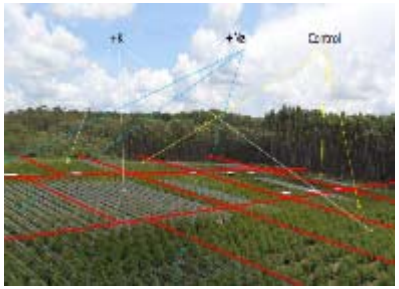
Exploring spatial variability on predicted maps

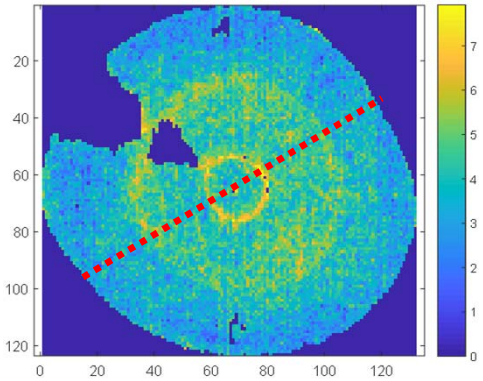


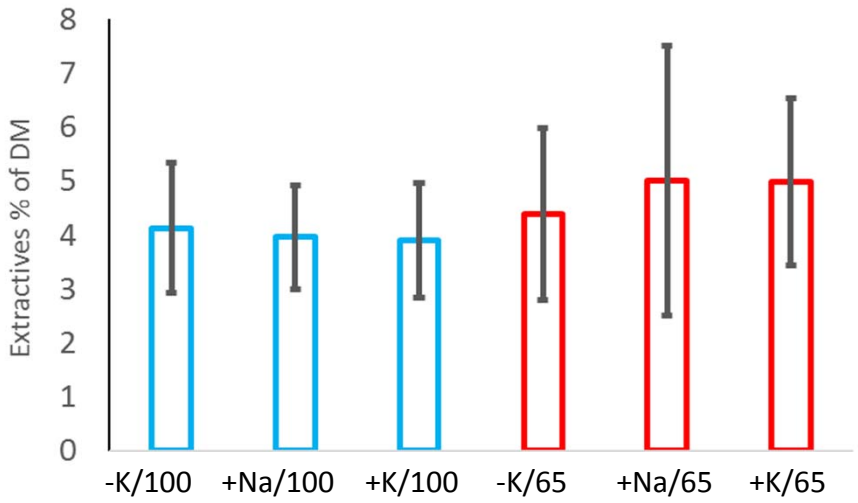
Determine annual and season rings

Design to measure secondary growth every 2 weaks

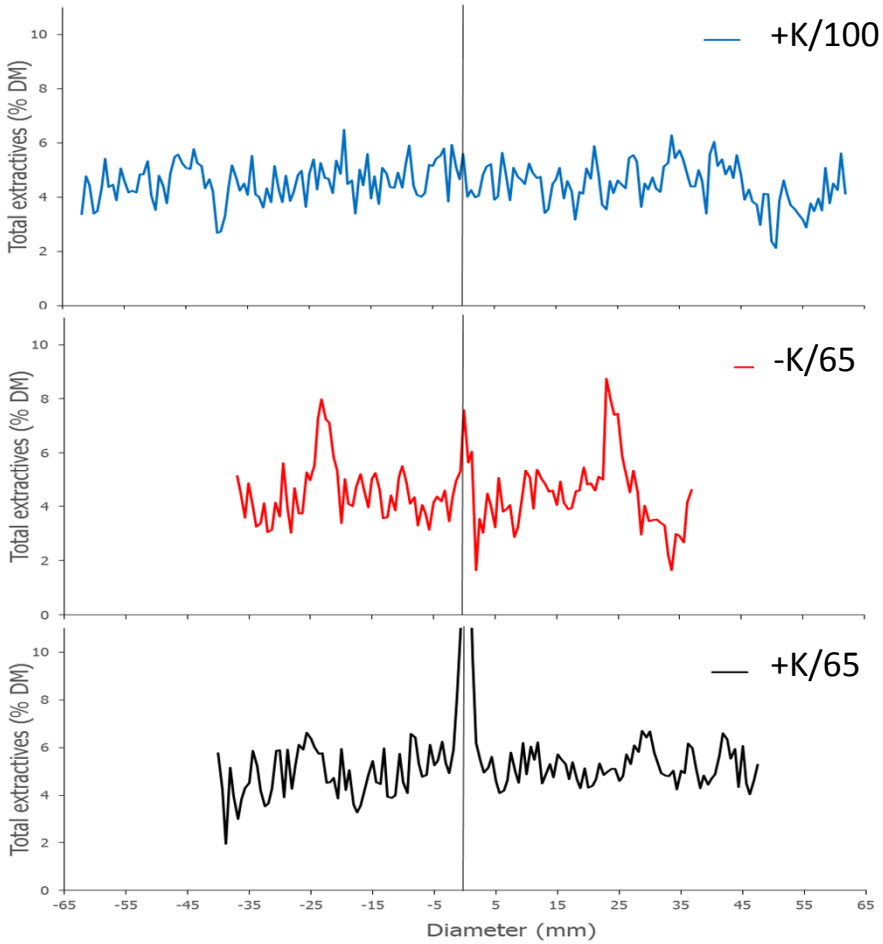
Water stress and seasons effects of total extractive content



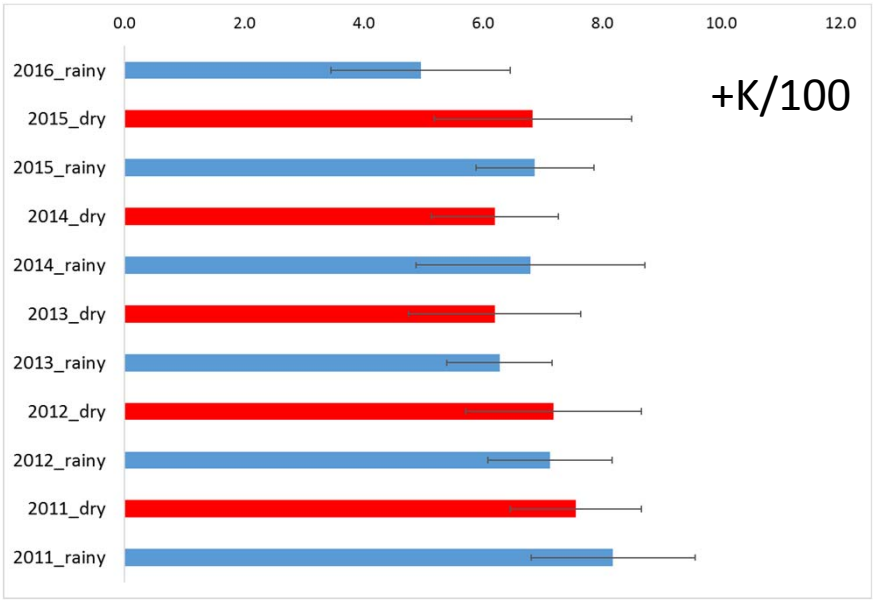


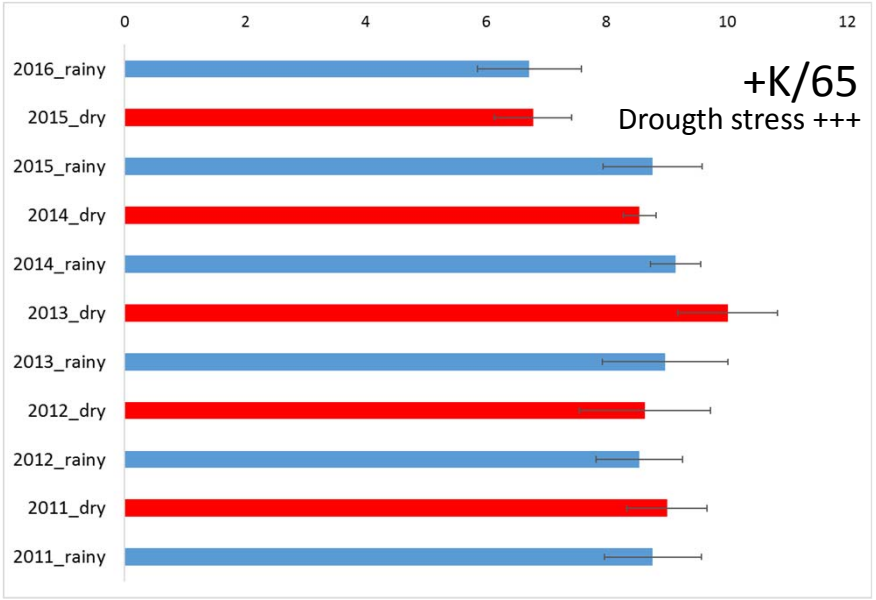


Distribution profile for total extractive content



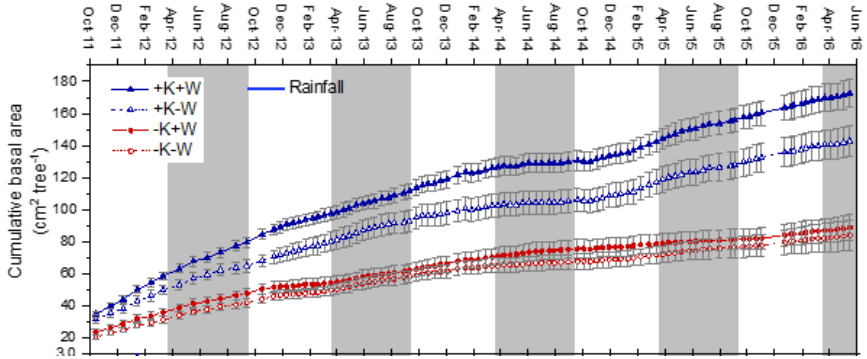
Water stress and seasons effects of total extractive content





Mean extractives %

CV	+K/100	+K/65
2016_rainy	30.3	12.9
2015_dry	24.2	9.5
2015_rainy	14.3	9.4
2014_dry	17.2	3.2
2014_rainy	28.2	4.6
2013_dry	23.2	8.3
2013_rainy	14.1	11.6
2012_dry	20.5	12.6
2012_rainy	14.6	8.4
2011_dry	14.5	7.4
2011_rainy	16.8	9.2



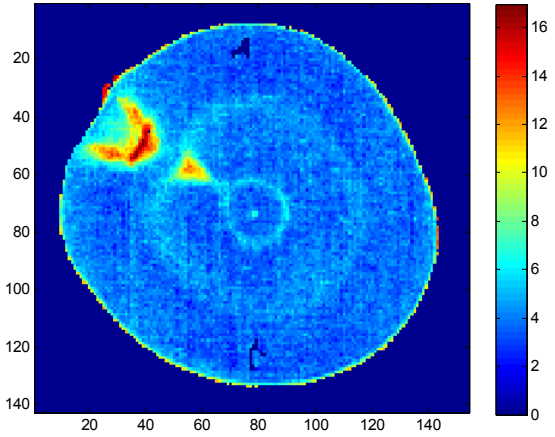
-20% of diametral growth

Water content in soils is higher

Other properties: Lignine, Cellulose

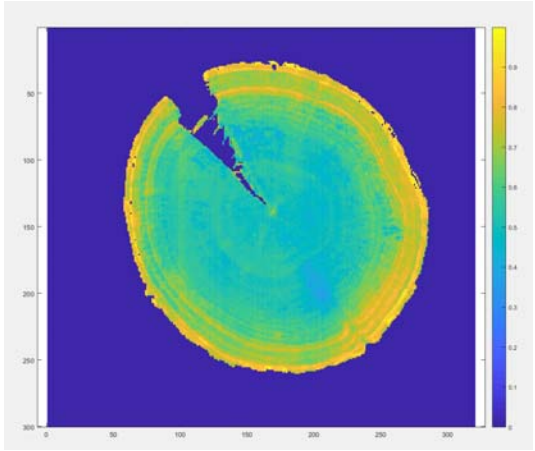
Perspectives – Wood properties and cambial activity under stress

1- HIS – chemical map

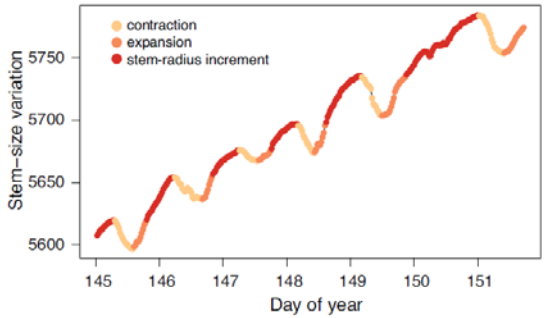


Geo-statistic / radial and longitudinal variabilities for **extractives, lignine, cellulose**

2- HIS – wood density map



3- Secondary growth profile (each 30 minutes)



X

Climatic data (each 30 minutes, daily, …)

Environment effects on cambial activity

Adaptation/plasticity, impact on selection
Extreme climatic events

Consequences on end-product
Identification of proxy/markers for selection

Phd works Mariana Pires Franco, Roger Chambi et al

Many Thanks!

gilles.chaix@cirad.fr

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